

The Gephyrea of Japan.

By

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With 4 plates

Only four species of Gephyreans, so far as I am aware, have hitherto been recorded from Japan, viz., *Phymosoma japonicum* GRUBE, *Dendrostoma blandum* SEL. & DE MAN, *Phascolion lucifugax* SEL. & DE MAN and *Echiurus uncinatus* v. DRASCHE. From my studies of the group during several years, 34 more species have become known to me, thus giving in all 38 species to the Gephyrean fauna of Japan as at present known. But of the four previously known species mentioned above, *Phascolion lucifugax* has, till the present day, remained wholly missing in my collection.

In this paper I propose to give short descriptions of, and comments upon, all the 37 species directly known to me.

Of the said 37 species, 26 belong to the Sipunculoids under 7 genera and 11 to the Echiuroids under 3 genera. Again, 24 species of them seem to be new; the remaining 13 species I have identified with those which other investigators have described from different parts of the world. It should be mentioned that

this identification could in several cases be made only with a greater or less degree of doubt as to its correctness. This is due, I think, mainly to the excessive conciseness of terms in which most of the old species (especially in the Echiuroidea) were described.

I have not deemed it necessary, for the present at least, to create a new genus for the reception of any of the new species, although the thought frequently suggested itself to my mind that some of the forms, e.g. *Thalassema tænioides* n. sp., might well be made the type of a distinct genus.

At the end of the paper will be given a key to all the species treated of, which may help students of the same field in the task of identification.

For the purpose of obtaining my material I have made frequent visits to the Misaki Marine Laboratory. Further I may mention that on a collecting trip to the Island of Amani-Ōshima (Province of Satsuma) and the Islands of Riukiu in 1901, and on others to the Province of Aomori in 1900 and to Gogoshima (Province of Iyo) in 1903, special attention was paid to the Gephyrean fauna.

To a number of friends, whose names will be mentioned in the proper places, I am indebted for gifts of several valuable specimens, some of which I should otherwise have been unable to obtain.

SIPUNCULOIDEA.

Genus PHASCOLOSOMA.**PHASCOLOSOMA NIGRUM, N. SP.**

(Figs. 1, 25-27).

This new species (Fig. 1) is of a moderate size, the total length being about 10 *cm.* The introvert is nearly $2\frac{1}{2}$ times as long as the body proper, than which it is slightly narrower. The posterior end of the body is always conically pointed. The body in life is coiled more or less in a spiral-like manner. The greater part of the body is dark gray or bluish-black in color, except the tentacular basis of the introvert where it is light brown. The tentacles, of a clear violet color, are filamentous and very numerous, arranged in 30-32 longitudinal rows. When viewed from above, the oral ends of every set of two tentacular rows are joined by a U-shaped ridge, the mouth being thus surrounded by 15 or 16 of such ridges with radial grooves between. Small skin-bodies are very abundant and are distributed over the entire surface of the introvert and of the body proper. They are largest on the introvert-basis and on the posterior end of the body, in both of which parts they appear as low papillæ of 0.1 *mm.* diameter and 0.05 *mm.* height (Fig. 25). Each papilla is an elliptical and slightly elevated granular disc of a brownish black color; in its

centre there is a yellow and radially striated area bearing the opening of the subdermal gland. On the introvert these papillæ become smaller and smaller anteriorly, but without undergoing a noticeable change in height (Fig. 26). They show no striated central area, the entire surface being finely granulated. Neither hook nor spine is present on the introvert.

The inner surface of the body-wall is remarkably smooth and shiny. The longitudinal muscles in the same are continuous. The retractor muscles are only two in number, forming a ventral pair (Fig. 27, *vm*). They originate at the beginning of the posterior third of the body proper, close to the nerve-cord (*n*). In the anterior parts they are fused together into one flat band, running in contact with the long œsophagus (*oe*) on the ventral side. Along the dorsal side of the latter runs the dorsal vessel, the posterior parts of which are beset with numerous but short contractile villi (*cv*). The long intestinal convolution (*ic*) consists of about 20–25 double spirals, closely twisted around the spindle-muscle which posteriorly does not pass out of the spirals for fixation to the body-wall. Only one, but very long, fixing muscle (*fm*) extends between the posterior end of the œsophagus and a point in the body-wall situated a short distance in front of the origin of the left retractor muscle on the left hand side. The rectal intestine (*rc*) carries at its beginning a small blind sac, the rectal gland (*rg*). The rectum is fixed to the body-wall by two broad wing-muscles (*wm*). The segmental organs (*so*) are of a conspicuous length; they are free from the body-wall except at the external apertures which are situated a certain distance in front of the anus. They are colored with a deep reddish brown pigment. The anus is indicated on the outside by a prominent papilla. The sexual organs are, as is usually the case,

two slender wavy bands (*sv*), developed across the points of origin of the retractor muscles (*vm*).

The present species agrees in some points with *Phascolosoma semperi* SEL. & DE MAN, as described by SELENKA (28), but it can be readily distinguished from that species by the characteristic dermal papillæ. The same distinction may be pointed out as obtaining between the present species and *Phascolosoma fimbriatum* SLUITER (37).

Habitat: The species is one of the commonest Sipunculoids met with in the vicinity of the Misaki Marine Laboratory; it is also common along the coasts of the Tokyo Bay and of the Inland Sea. It lives in shallow muddy bottom, especially in small inlets into which fresh-water finds egress.

PHASCOLOSOMA JAPONICUM, N. SP.

(Figs. 2, 28 & 29).

The length of the body proper is about 5 *cm.* on an average, the introvert being about as long as two-thirds of the body proper (Fig. 2); the two regions pass over into each other without a distinct demarkation. The maximum width of the body proper is about 7 *mm.* The body-wall is thin and of a brownish yellow color, of a deeper brown in male worms than in female. To the naked eye the skin-surface appears quite smooth, but under certain magnification there are seen numerous skin-bodies of elliptical shape, thickly distributed (Fig. 28). These bodies are flat, not covered with chitinous plates, and are somewhat transparent; a

group of subdermal glands, situated beneath the skin-body, are seen to open to the exterior by a small common pore (see *p*) at the centre. The papillæ are of nearly the same size throughout the whole surface of the body, viz., 0.09–0.06 *mm.* in diameter. No hook or spine is present. The tentacles are filamentous and tolerably numerous, and are arranged in about 12–14 longitudinal rows around the oral disc, each row consisting of about five tentacles. The rows, in sets of two, are united at the oral end by U-shaped elevations as in the preceding species. Two dark brown eye-spots are present on the ganglion or brain (*g*, Fig. 29).

The longitudinal muscles of the body-wall are uniformly distributed. The inner surface of the wall is smooth and shiny like a pearl. There are present two pairs of retractor muscles, of which the ventral pair (*vm*) originate at about the middle of the body proper close to the nerve-cord (*n*), while the dorsal pair (*dm*) arise from a region a short distance behind the anus (*a*). The œsophagus (*oe*) is fixed by thin membranaceous muscles and is accompanied dorsally by the dorsal vessel (*dv*), which posteriorly reaches down to the beginning of the intestinal convolution (*ic*). This vessel develops no contractile villi. The intestinal convolution is made up of 17–23 double spirals and is traversed throughout by the spindle-muscle which at the posterior end is not fixed to the body-wall. There exist in all three fixing muscles, one on the right and two on the left side of the nerve-cord (see *fm*, Fig. 29). One on each side is attached to the beginning of the rectum, while the unpaired and asymmetrical one on the left side is fixed to the posterior terminal portion of the œsophagus. A large blind rectal gland (*rg*) is attached to the middle part of the rectum. The anterior portion of the rectum is fixed by well developed wing-muscles (*wm*). The two segmental organs (*so*),

the external apertures of which lie slightly in front of the anus, are tolerably long, corresponding in length to nearly one half of the body proper. They are of a deep brownish color and are entirely free from the body-wall except at the anterior end. The sexual organs (*sz*) are developed as two narrow transverse bands placed across the bases of the ventral retractor muscles.

Habitat: This species is common along the coasts of the Tokyo and Sagami Bays. It occurs very abundantly in shallow waters near the Misaki Marine Laboratory. The animals live in clean sand, mostly in narrow fissures of rocks. No specimens have thus far been obtained at any other locality than those mentioned above.

PHASCOLOSOMA MISAKIANUM, N. SP.

(Figs. 3, 30-33).

This species is small and slender. The total length of the animal with the introvert wholly protruded, measures about 5 *cm.*, the thickest part of the body proper rarely exceeding 2 *mm.* in width. The introvert corresponds in length to about four-fifths of the total length. The skin is smooth, thin and somewhat transparent; it is of a yellowish pink color (Fig. 3). Under high magnification there can be detected numberless small papillary bodies distributed all over the body-surface. In the posterior region of the body, where these bodies are most closely aggregated, they measure 0.03 *mm.* in both height and diameter. Here they take the shape of a small rounded cone, on the summit of which

numerous small chitinous granules of a yellow color are so arranged as to form a ring surrounding the external aperture of the subdermal gland (see Figs. 30 *a* and *b*). In the middle region of the body proper, the papillæ are quite flat, elliptical in form and much larger than in the posterior region. The chitinous granules of such papillæ are much smaller than those referred to above. In the introvert, the papillæ are very slightly elevated (nearly 0.015 *mm.* in height) and so small that they might appropriately be called tubular with “Mündungskörper” (Fig. 31). The introvert carries about 60 ring-rows of hooks of a small size. The hooks in a way alternate in position with the tubular papillæ, there being about five of the former between every two of the latter. The hooks are 0.025 *mm.* high, light yellow in color, and are provided with a sharp and strongly curved apical tooth and 4–5 short accessory teeth (Fig. 32). The accessory teeth gradually decrease in number in the hooks forming the more posterior rings finally to disappear altogether. The tentacles are filamentous and nearly always 8 in number, surrounding the oral aperture. The eye-spots are seen as two small, brown specks lying on the lateral corners of the ganglion.

The longitudinal musculature of the body-wall is continuous. Of the two pairs of the retractor muscles, which are all slender, the ventral pair (*vm*, Fig. 33) originate at the middle of the body proper, while the dorsal (*dm*) do so far more anteriorly. The anus lies at a position nearly midway between the origins of the two pairs of muscles. A feature peculiar to this species is presented by the sexual organs (*sx*). These are narrow band-like structures situated at a considerable distance behind the origin of the ventral retractor muscles. The dorsal vessel (*dv*) is very short, extending posteriorly for only a few millimeters beyond

the ganglion, and is not provided with contractile villi. The intestinal convolution (*ic*) is formed of 6-10 double spirals which are more or less irregularly twisted around the fine spindle-muscle (*sm*). The latter is fixed to the body-wall at both its anterior and posterior ends. Its anterior end is at a considerable distance anteriorly from the anus. There is only one fixing muscle (*fm*), connecting the hind end of the œsophagus (near the commencement of the convolution) with the body-wall on the left side of the nerve-cord and a short distance in front of the origin of the ventral retractor muscles. No blind diverticulum is present on the rectum. The latter is supplied with wing-muscles (*wm*). The segmental organs (*so*) exhibit a peculiar structure unknown in other Sipunculids. Each of them consists of two long lobes equal in size and shape, the one being directed anteriorly and the other posteriorly. The two lobes are directly continuous with each other. At their boundary lies the external aperture, the inner aperture or the funnel being found at the basis of the anterior lobe. The organs have a reddish yellow color. Their wall is very thin.

Habitat: The animals are discovered under sea-weeds covering a tufaceous sandstone between the tide-marks. They have hitherto been collected only on the shores near the Misaki Marine Laboratory, where however they are rare.

PHASCOLOSOMA OKINOSEANUM, N. SP.

(Figs. 4, 34-38).

In March, 1901, a single specimen of the species here described as new under the above name was dredged at a depth of

400 *hiro** (near the Okinosé bank) in the Sagami Sea. The following description is based on that specimen which is preserved in formalin.

The worm is of a moderate size and of a brownish yellow color. The body proper is about 4.5 *cm.* in length and 7 *mm.* in maximum width, it being posteriorly narrowed into a small and slender tail-process (Fig. 4). The introvert, which had partly retracted, is apparently about as long as the body proper, but much narrower, averaging 3 *mm.* in width. The skin-surface appears smooth to the naked eye, but under certain magnification numberless prominent papillæ may be discovered. They are largest and tallest in the posterior region of the body, reaching up to 0.08 *mm.* in height and 0.03 *mm.* in thickness (Fig. 34). They are of a brownish yellow color and are composed of very small, closely aggregated, chitinous granules. The papillæ become gradually shorter and shorter towards the base of the introvert, in which parts they are represented by flat bodies separated from one another by irregular narrow grooves (Fig. 35). The latter form a sort of mesh-work, in the meshes of which is contained a papillary body. Each body is formed of a small granular ring of a brownish yellow color and of a colorless transparent central area containing the small external aperture of the subdermal gland. The granular ring measures about 0.03 *mm.* in diameter. Towards the middle and anterior parts of the introvert, the papillæ again become nearly as large and long as in the posterior parts of the body. In the regions of the introvert mentioned, the chitinous layer of the skin shows fine striations intersecting at right angles. No hook or spine, nor eye-spot, is present. Peculiar structures are

* 1 *hiro*=about 5 feet.

found on the skin-surface of the body proper; we have here to do with tolerably large, elongated sacs with a thin, colorless and transparent wall. Fig. 36 represents one of the structures greatly magnified. The organ is hollow; its cavity communicates with the body-cavity by a small aperture which is situated just at the basis of the organ and is perfectly round in contour (Fig. 37). As Fig. 37 shows, the wall contains a number of longitudinal muscle-fibers (*mf*) running parallel to one another. A closer microscopical examination shows that most of these muscle-fibers are proximally continuous with the circular muscles of the body-wall. From the structure and the relation of the organs to the body-cavity, it seems very probable that they serve as the respiratory apparatus. They are found here and there all over the surface of the body proper, but are most numerous in the posterior region.

The longitudinal muscles are everywhere continuous. The inner surface of the body-wall is of a shiny appearance. There exist two pairs of the retractor muscles, which are fairly long and very slender. The ventral pair (*vm*, Fig. 38) spring from the posterior border of the anterior one-third of the body proper, while the dorsal pair arise about 7 *cm.* in front of that border. The sexual organs (*sx*) are developed as two narrow wavy bands attached to the base of the ventral retractor muscles (*vm*). The intestinal convolution (*ic*) is long and conspicuous, consisting of about 20 double spirals closely twisted around the spindle-muscle (*sm*) which posteriorly is not fixed to the body-wall. Three fixing muscles (*fm*) are present. One of them originates inside the base of the left ventral muscle and ends at the posterior free part of the œsophagus. The other two are rooted each on one side of the nerve-cord and are attached to the beginning of the rectal

intestine. Just opposite these two points of attachment, there is found a small roundish rectal diverticulum. The segmental organs (*so*) are relatively short and small, measuring about 10 *mm.* in length. They are transparent and almost colorless tubes, unaccompanied by a mesentery. Their external openings are situated nearly on the same level as the anus (*a*). The presence of the dorsal vessel could not be ascertained. The tentacles, surrounding the mouth, are filamentous and very numerous.

PHASCOLOSOMA OWSTONI, N. SP.

(Figs. 5, 39-44).

The single specimen (Fig. 5), on which this species is based, was dredged in 1899 by Mr. Owston of Yokohama from a depth of 180 *hiro* in the Uraga Channel. It has been preserved in formalin.

The total length of the animal is 8 *cm.*, one-fourth of which appertains to the introvert. The posterior half of the body proper is wider than the anterior and measure 8-10 *mm.* across. The entire introvert is nearly of the same thickness as the anterior and narrower part of the body proper. The ground color of the skin is a light blue, suffused with pink; the middle portion of the introvert is tinted a deep brown, and the posterior portion of the body-proper a light brown. The body-wall is in the body proper relatively thin, smooth on the external surface and more or less transparent, while in the introvert it is thick, opaque and has a closely wrinkled surface. All over the sur-

face of the body there are sparsely distributed papillæ. In the posterior region of the body proper, these are very large and long, measuring 0.125 *mm.* in height and 0.054 *mm.* in thickness. Each papilla is covered with a number of small chitinous granules of a reddish brown color; the apex is bored through by a small pore leading into the subdermal gland (Fig. 39). Towards the introvert-basis, the papillæ become gradually shorter and shorter, until in that region they are very short and assume the shape of a round disc of a yellowish color (Fig. 40). Fine radial striation is found in the central chitinous plate containing the aperture of the subdermal gland. The more anteriorly situated papillæ of the introvert are once again more prominent and those close to the hooked region have the form of a moderately tall (0.04–0.07 *mm.*), round-pointed process covered with small chitinous granules of a yellowish color (Fig. 41). The hooks (Fig. 42), without being arranged in ring-rows, are extensively distributed behind the tentacular region of the introvert. They are 0.22–0.13 *mm.* high, slender and almost straight; and of a brownish yellow color.

The longitudinal muscles are quite continuous and the inner surface of the body-wall is shiny like a pearl. The retractor muscles (*dm*, *vm*, Fig. 43) are three in number, the right ventral retractor being absent. The left ventral retractor (*vm*) arises at the beginning of the middle third of the body proper, close to the nerve-cord, while the two dorsal retractors (*dm*) originate immediately behind the anus (*a*). The two muscles of the left side are entirely coalesced into one band, and anteriorly are again joined to the dorsal retractor of the right side. In spite of the absence of the right ventral retractor, the sexual organs (*sx*) are symmetrically developed as two slender transverse

bands stretching along the basal line of the left retractor, as well as in the corresponding position on the right side. The œsophagus (*œ*) is connected by a membranous muscle with the inner side of the left ventral muscle. The dorsal vessel (*dv*) runs along the entire dorsal side of the œsophagus; it is not provided with contractile villi. The intestinal convolution (*ic*) consists of about 30 double spirals around the spindle-muscle (*sm*). The latter does not posteriorly pass out of the spirals to insert itself in the body-wall. The small diverticulum attached to the beginning of the rectum is comparatively short. Two fine fixing muscles (*fm*, Fig. 43), are attached to the fourth spiral of the convolution; they are rooted on the body-wall at points lying just behind the bases of the dorsal retractor muscles. The segmental organs (*so*), of a deep reddish brown color, are of a moderate size. Their external apertures are situated on the same level as the anus (*a*). Tentacles are tolerably numerous and encircle the mouth in a ring. No eye-spot can be detected on the ganglion.

A peculiar reticular structure (*rt*, Fig. 43) is found lining the inner surface of the body-wall in a zone bounded anteriorly by a line joining the external apertures of the segmental organs and posteriorly by a line running midway between the roots of the dorsal and ventral retractor muscles. It appears as an irregular, small-meshed network of trabeculæ, forming a layer over the region indicated. One small portion of the structure is shown in Fig. 44, as seen in surface view under a low magnifying power. Examined on sections, the trabeculæ are seen to be composed of very fine connective-tissue fibers in bundles and of a few muscle-fibers; further it can be made out that the reticular layer is joined to the body-wall by numerous short

bridges which mostly arise from the nodal points of the reticulum. It scarcely needs to be pointed out that the bridges as well as the trabeculæ are covered by the peritoneum. I am at present quite at a loss to explain the physiological significance of the structure. Possibly it is nothing but a certain pathological product.

Genus PHASCOLION.

PHASCOLION RECTUS, N. SP.

(Figs. 45-49).

This new species is based on a single specimen which was obtained, September 1903, from a depth of 400 *hiro* in the Sagami Bay by means of the long-line (Dabonawa). It has been carefully preserved in alcohol.

The worm inhabits the dead shell of a *Dentalium*, the introvert partially protruding out of the larger aperture. The body not being cemented to the shell lies free. The entire length of the worm is about 35 *mm.*, nearly one-third of which constitutes the partly retracted introvert (Fig. 45). The body proper is nearly straight, gently swollen in the middle where it measures about 2 *mm.* across, while the introvert is relatively thick and about 1 *mm.* broad. The skin is of a grayish yellow

color, more deeply yellow in the middle portion of the body proper. The greater part of the body-surface appears nearly smooth to the naked eye, except on the introvert-basis which is rough on account of the presence of tall papillæ and prominent chitinous folds. Under the microscope, it is seen that the apparently smooth part of the surface is beset with skin-papillæ which vary much in shape and size in different portions of the body. In the anterior region of the introvert, the papillæ are very small, transparent, oval bodies, measuring 0.025 *mm.* in height and 0.014 *mm.* in basal diameter. From that region posteriorly, they become somewhat larger and taller, but less closely arranged, and in the middle parts of the introvert they measure about 0.028 *mm.* in height and 0.02 *mm.* in maximum breadth (Fig. 46). On the introvert-basis, the papillæ are rather prominent, showing a club-like shape and measuring about 0.1 *mm.* in height and 0.05 *mm.* in thickness in the broadest part. They have a thick wall, are yellow in color and are perforated by a narrow and likewise club-shaped canal which proximally communicates by a small pore with the cavity of the subdermal gland (Fig. 47). The minute external aperture on the apex of the papilla can scarcely be brought into view. Intermixed with the papillæ are present large, irregularly shaped thickenings of the chitin (see Fig. 47); these appear finely granulated and are of a deep brown color. In the anal region, the papillæ abruptly become short (0.04 *mm.* high) and exhibit a conical form with a basal diameter of 0.046 *mm.* on an average. The apex of such a papilla is occupied by a small mamelon-like body which is pierced through by the papillary canal. Most of these papillæ are situated amongst closely set, large and irregular chitinous thickenings of coarsely granular appearance

and of a deep brown color. Behind the anal region, the papillæ become gradually smaller until in the middle region of the body proper they acquire the form of an almost flat body, measuring 0.02–0.03 *mm.* across at base (Fig. 48). Structurally these flattened papillæ agree with those of the anal region. The skin-surface here also is covered with small chitinous thickenings of various forms and sizes peculiar to this region (see the above figure). At the posterior end of the body the papillæ are once again of a somewhat conspicuous size: here they measure on an average 0.05 *mm.* in height and 0.10 *mm.* in diameter. These, in both their external and internal structure, are quite similar to those found in the middle region of the introvert. No hook or any spiny structure is present on the introvert.

The longitudinal musculature forms a continuous sheath. Only a single and very slender retractor muscle (*rm*, Fig. 49) springs with two short roots from the posterior end of the body. The intestinal convolution consists of about 20 irregularly twisted spirals and is not accompanied by a spindle-muscle. The intestinal spirals are joined to the body-wall by means of four fine fixing muscles (*fm*), two of which are attached to the beginning and the two others near the posterior end of the convolution. The dorsal vessel is about 15 *mm.* long; it is not provided with contractile villi. The segmental organ (*so*) is situated immediately behind the anus as a single elongate sac lying on the right side of the nerve-cord; it is unaccompanied by a mesentery. No eye-spot is found on the ganglion. The tentacles, about 10 in number, are filamentous.

Phascolion rectus agrees with *Phascolion manceps* SEL. & DE MAN, in wanting the "Haftpapillen" and the hooks and

also in having only one retractor muscle, but differs from it, amongst other less important points, in the shape and structure of the papillæ, in the absence of contractile villi on the dorsal vessel and in the position of the anus in relation to the introvert.

PHASCOLION ARTIFICIOSUS, N. SP.

(Figs. 6, 50-55).

Two specimens of the new species here described under the above designation, were collected, July 1903, from a depth of 400 *hiro* in the Sagami Bay. They were both occupying small Gastropod shells. One of them was observed by me in the fresh state and is shown in Fig. 6, enlarged about 10 times.

The aperture of the dead shell inhabited by the worm is plugged with a conical mass of cemented sand having at the apex a pore, out of which the introvert of the worm is partly extruded (Fig. 50). When extracted from the shell, the worm-body is found to be spirally twisted in accommodation to the spiral of the shell. The skin is of a bluish gray (in the fresh state), but bluish black on the closely set papillæ. The body proper is about 1.5 *cm.* long and 3.-3.5 *mm.* thick, while the introvert is about half as long and somewhat narrower (2 *mm.* wide). The papillæ are closely distributed over the entire surface, and vary much in size and shape in different parts of the body. The largest are found in a narrow zone around the middle of the posterior half of the body proper. Here they are of a low conical shape and appear like the so-called "Haft-

papillen" (Fig. 51). The dark-colored apical parts of these papillæ are more or less laterally compressed so as to be flattened. The larger ones measure 0.1–0.2 *mm.* in basal diameter and 0.8–0.15 *mm.* in height. In the remaining regions of the body proper, except at its very anterior end, the papillæ are in general very much smaller and of a bluntly apexed conical shape. In the middle region, the papillæ commonly do not exceed 0.05 *mm.* in basal diameter and in length. In the posterior end they are somewhat larger, measuring 0.1 *mm.* in average length, and take the shape of a pear-shaped sac with a pointed apex (Fig. 53, Pl. III). In the extreme anterior region, the papillæ are of a shape quite different from those of all other regions. Here they are no longer conical, but are represented by finger-like processes of about 0.07 *mm.* height and 0.04 *mm.* thickness (Fig. 54). The chitinous wall of such a papilla is, especially on the apex, thick and of a yellowish brown color. On the introvert-basis, there again appear conical papillæ similar to those of the body proper. They gradually decrease in size towards the introvert-tip. Fig. 52 represents some papillæ from the middle region of the introvert; here they are seen as transparent, thin-walled processes, 0.04–0.07 *mm.* high and conical in shape but with the apex rounded. No hook or spine can be found on the introvert. The tentacles are simple and not numerous, probably 10 in number.

The longitudinal muscles form a continuous sheet. There are two retractor muscles, one of which is very small and the other (the ventral?) relatively large. The latter arises with two short roots from near the posterior end of the body (*rm* and *rm'*, Fig. 55). The intestinal convolution (*ic*) consists of a few irregular spirals unaccompanied by muscles of any sort. There

is a single segmental organ (*so*) situated on the right side of, and close to, the nerve-cord (*n*). It represents an elongate sac, arising freely from the body-wall.

This species seems to be most closely allied to *Phascolion lucifugax* SEL. & DE MAN, a young specimen of which is said to have been obtained by HILGENDORF in this country. The two species resemble each other especially in having large papillæ in a zone around the middle region of the body proper. But the present species certainly differs from *Phascolion lucifugax* in possessing differently shaped papillæ and in being devoid of hooks on the introvert.

Genus PHYMOSOMA.

PHYMOSOMA SCOLOPS, SEL. & DE MAN.

SELENKA, (28), 1883, *p.* 75.

From SELENKA'S description the specific character of this species may be summed up as follows :

Entire body-length 4 *cm.* on an average. Color reddish brown, often yellowish brown. Introvert bears on the dorsal side numerous pigmented bands of a reddish brown or brownish black color. Papillæ black, tolerably large, but little elevated in the middle region of the body proper ; they consist of brown plates which become gradually smaller towards the peripheral

border. On the introvert-basis and the posterior end of body, the papillæ are conspicuously large and elevated. Hooks about 0.07 *mm.* high, provided with two sharp teeth at the apex and with warts ("Runzeln") at the base; hook-rows about 15-17 in number, between them small hook-papillæ ("Hakenpapillen"). Eye-spots distinct. Tentacles, about 12, arranged in a semicircle above the mouth.

Longitudinal muscles 20-21, rarely anastomosing. Four retractor muscles arising from the middle of the body-proper: the dorsal pair from the 1st-2nd and the ventral from the 5th-6th longitudinal muscles. The intestinal convolution consists of 12-14 spirals, and has a fine spindle-muscle fixed at both ends. The one fixing muscle present is bifurcated towards the intestinal attachment. The segmental organs are half as long as the body proper; the anterior third or fourth of their total length is fixed by a mesentery to the body-wall.

In Japan this species has been collected from the Hokkaido in the north to the Riukiu Islands in the south. As in many other cosmopolitan forms, the species shows remarkable variations, especially in color, according to different surrounding conditions. Specimens from the Riukiu (Loo-choo) Islands and the Ogasawara Islands exhibit all the essential characters described by SELENKA (28) and other authors,—as, for instance, the black crescent-shaped markings on the introvert, papillæ and hooks of the same form and size, &c. Those from the main island of Japan are in several respects slightly different from the above mentioned form. Thus, the individuals living among Ascidian colonies or eroded tufaceous sandstone, show an extremely wide range of variation with regard to the general color of the body and the size and color of the

papillæ. The specimens I collected on the shores of the Aomori Bay, are entirely devoid of the characteristic markings on the introvert, while the skin-papillæ are in general unusually tall. A form similar to the above is also frequently obtained on the shores of Misaki.

PHYMOSOMA JAPONICUM, GRUBE.

SELENKA, (28), 1883, *p.* 76.

The main features of this species are embodied in the following extract from SELENKA's description :

Body proper of larger specimens, about 5 *cm.* in length ; twice as long as introvert. Color, gray or grayish brown. Papillæ visible as reddish brown specks ; they are formed of polygonal plates arranged in concentric circles. About 25–30 hook-rows, —in the younger individuals, sometimes even as many as 100, —are present on the introvert. Hooks 0.07 *mm.* long, very flat laterally, provided with two sharp teeth at apex, and with warts (“Runzeln”) at base. Tentacles, about 28 in number. Two brown eye-spots present on the ganglion.

Longitudinal muscles are divided into about 30, frequently anastomosing bundles. Four retractor muscles arise from the middle one-third of the body proper, the dorsal pair being rooted in front of the ventral pair. Dorsal vessel tolerably long, without contractile villi. Intestinal convolution consists of 10–12 double spirals, traversed by a spindle muscle fixed at both ends to the body-wall. A single fixing muscle is attached to the first intestinal spiral. Two long and moderately large segmental organs extend

posteriorly to the roots of the dorsal retractor muscles; about the anterior half of the organ is connected with the body-wall by a mesentery.

A large number of specimens from Enoura in the Province of Suruga, referable to this species, are preserved in the Zoological Museum of the Science College, Imperial University of Tokyo. I myself have obtained three specimens from a shallow bottom (5 *hiro* deep) near the Misaki Marine Laboratory. According to SELENKA, HILGENDORF collected the species at Enoura and also at Hakodate. It seems highly probable that this species will be found in more southern localities than Enoura, for the fauna of Enoura, as is admitted by all Japanese zoologists, comprises many subtropical forms.

In dissecting specimens of the present species, it almost always happened that a moderately large globular body was found attached to the dorsal side of the œsophagus nearly always in the same position. I have ascertained by a study of sections that the said body is a sac which contains a number of small parasitic worms; the parasites are imbedded in a dense mass of leucocyte-like cells. Each parasitic worm is externally enveloped by a rather thick cuticula of a bright yellow color; it is provided with a large and a small sucker, both situated on the flattened side of the body. SPENGEL described quite similar worms in the general body-cavity of *Balanoglossus kupferi*; he thought them to be the young of a Distoma species. As to the body-form, the structure and position of the two suckers, *etc.*, I see no noticeable difference of importance between the parasites described by SPENGEL and those found by me in *Phymosoma japonicum*.

PHYMOSOMA ANTILLARUM, GRUBE and OERSTED.

SELENKA, (28), 1883, *p.* 57.

From SELENKA'S description the specific characters of this species may be summed up as follows :

Length of body-proper 3 *cm.*; length of introvert 18 *mm.* Skin yellow, thick, covered with low blackish brown papillæ. On the introvert, the papillæ are of a tall conical form, sparsely distributed. Around the basis of filiform tentacles, of which there are 50-80, there is present a collar-like skin-fold. Two eye-spots on the ganglion.

Longitudinal muscles of the body-wall are divided into bundles, which very frequently anastomose with one another. Intestinal convolution consists of about 20 spirals. Rectal intestine long. Spindle muscle is fixed to the body-wall at both ends. A single fixing muscle joins the first intestinal spiral. Dorsal vessel carries very numerous, finger-shaped contractile villi. Segmental organs are about half as long as the body proper, their entire course being accompanied by a mesentery.

Five specimens of this species were collected on the Islands of Amani-Ōshima (Koniya) and of Okinawashima (Naha, Itoman, Chinensaki). The general external features as well as the anatomical characters agree well with KEFERSTEIN'S original description of this species. The Japanese specimens however are much smaller than those collected in the West Indies (St. Thomas I.). Of the former the largest in my possession does not exceed in

total length 22 *mm.*, of which about 15 *mm.* appertain to the introvert. The number of longitudinal muscles in the anterior half of the body proper, is on an average 14, while in the posterior half each longitudinal muscle divides twice successively before reaching the posterior end of the body. The tentacles, filamentous in form and about 30 in number, are arranged in one row, ventrally and laterally to the mouth. Each tentacle bears in the fresh state, as was mentioned by KEFERSTEIN, two narrow band-like markings of a bluish black color.

The anus and the external apertures of the segmental organs lie at the same level; the latter perforate the body-wall between the second and the third longitudinal muscles. The roots of the two retractor muscles spring from the 2nd–4th longitudinal muscles. Rectal diverticulum is not present. Two distinct eye-spots are found on the ganglion.

Specimens are obtained by breaking coral rocks.

PHYLOSOMA PACIFICUM, KEFERSTEIN.

SELENKA, (28), 1883, *p.* 63.

The main features of the species as embodied in SELENKA's description are as follows:—

Body proper, 8 *cm.* in length and 14 *mm.* in maximum breadth. Introvert longer than body proper, so that the whole length may reach 29 *cm.* Color grayish, blackish, or reddish brown; often with small black specks; introvert generally bears on the dorsal side irregular pigmented bands. Body-wall thick,

hard, and with very rough surface on account of the presence of tall (0.3 *mm.* high) papillæ which are closely set. Hook-rows 80–100, consisting of tall (0.10 *mm.*) hooks which are provided with a sharp and strongly curved apical tooth and a small blunt accessory tooth. Tentacles 35–40 in number, arranged in a semicircle above the mouth.

Longitudinal muscles, divided into separate but frequently anastomosing bundles, number 30–35 in the posterior half of the body proper. In young individuals, they are sometimes found in the continuous state. Of the four retractor muscle, the ventral pair are rooted in the middle third and the dorsal pair in the anterior third of the body proper. Intestinal spirals, 12–14 in number. Rectal intestine short. Spindle-muscle fixed at both ends. Only one fixing muscle is present. Segmental organs very long, reaching nearly down to the posterior end and accompanied by a mesentery along the whole length.

Numerous specimens of this species were collected by me, in April 1901, on the Islands of Amami-Ōshima (Nase) and of Okinawashima (Chinensaki and Naha). They burrow in fissures of coral rocks along the tide marks.

PHYMOSOMA ONOMICHIANUM, N. SP.

(Figs. 7, 56–58).

The present species is based on a single specimen which I discovered in a collection made by Mr. Izuka, in 1901, in the inlet of Onomichi (Province of Bingo). The specimen is pre-

served in formalin and therefore keeps the natural color almost unchanged.

The animal is of a moderate size (Fig. 7), the body proper measuring about 30 *mm.* in length and 9 *mm.* in maximum breadth. The introvert, which is entirely retracted, is much more slender than the body proper, being only about 2 *mm.* thick. The body-wall is yellowish brown and is covered with large, variously shaped papillæ of a deep brown color. In the middle region of the body proper, the papillæ are but slightly elevated bodies of 0.25 *mm.* basal diameter, each consisting of polygonal chitinous plates of a deep brown color and various sizes (Fig. 56). The small lighter colored area (marked with $\times$ in the fig.) in the centre of the papilla, is perforated by the minute external opening of the subdermal gland. The non-papillated parts of the surface, in this region of the introvert, is covered with sparsely scattered chitinous plates which seem to be of the same character as those of the papillæ. On the introvert-basis as well as in the posterior region of the body proper, the papillæ are conspicuously tall, taking the shape of an obtusely apexed cone (Fig. 57*a*, taken from the region of the introvert-basis). It measures on an average 0.20 *mm.* in height and 0.25 *mm.* in basal diameter, and is constructed of thick chitinous plates of irregularly polygonal shape, closely set together in a pavement-like manner; the plates at the papillar base are the largest and the deepest in color (brown). A small pore (*p*, Fig. 57*b*) opens at the apex of the cone, surrounded by a circular area. No hook or spine is present on the introvert; nor can eye-spots be detected on the ganglion. The tentacles are filamentous and are remarkably numerous, entirely surrounding the mouth.

The longitudinal muscles are divided into separate, but very frequently anastomosing, bundles; in the region of the segmental organs they are 16 in number and in the posterior region of the body about 22. The retractor muscles (Fig. 58) occur in a single ventral pair, the dorsal pair being wanting. The pair present are attached to the body-wall at the beginning of the posterior third of the body proper. The intestinal convolution consists of about 15 double spirals, twisted around the spindle-muscle (*sm*) which is fixed at its posterior end. The intestine is suspended by two fixing muscles (*fm*), both of which lie to the left of the nerve-cord (*n*); one of them arises just behind the root of the left retractor muscle, and is joined to the posterior part of the intestinal convolution, while the other arises at a point of the body-wall about 7 *mm.* in front of the origin of the first and ends at the first spiral. There is no blind diverticulum on the rectum. The anus (*a*) is situated near the anterior end of the body proper, at the same level as the external apertures of the segmental organs. These (*so*) are long, being nearly half as long as the body proper; throughout their whole length they are attached to the body-wall by a thin mesentery. The contractile villi of the dorsal vessel are very numerous and tolerably long, reaching up to 2 *mm.* in length; some of them show a slight ramification.

The most remarkable characters of the species consist (1) in the total absence of hooks and (2) in the retractor muscles being present in a single pair. No form combining these two characters seems to have been hitherto recorded.

Habitat: The sandy shore of the Inlet of Onomichi in the Inland Sea.

PHYMosOMA NAHÆNSE, N. SP.

(Figs. 8, 59–62).

I collected two specimens of this species, in April 1901, at Naha (Naminouye) in Okinawashima, one of the Islands of Riukiu. In external features they closely resemble *Phymosoma scolops* SEL., for which species they were at first mistaken by me.

In the larger of the two specimens, the introvert is entirely protruded, the total body-length measuring 45 *mm.* and the maximum breadth about 8 *mm.* (Fig. 8). The skin is of a brownish yellow color, more deeply tinted at the introvert-basis and at the posterior body-end. Over the entire surface there are distributed tolerably large, but very slightly elevated papillæ. In the middle region of the body proper, these are nearly flat and elliptical in shape, measuring on an average 0.13 *mm.* by 0.10 *mm.* across (Fig. 59). They are thickly covered with numerous round chitinous plates which gradually become larger towards the central area (denoted by $\times$ in the fig.) containing the small aperture of the subdermal gland. The papillæ gradually grow taller towards both ends of the body proper. In the introvert-basis they are on an average 0.2 *mm.* high and towards the posterior end of the body 0.15 *mm.* Hook-rows are numerous and consist of small hooks, about 0.04 *mm.* high, which are provided with a sharp and strongly curved apical tooth (Fig. 60). In the side view of the hook there are seen a transverse bar (*b*) across the base and two rows of warts (*rz*) ("Runzeln"). Both the hooks and the warts are of a reddish yellow color.

Between every two rows of the hooks, there are further found numerous perforated papillæ or "Mündungspapillen" (Fig. 61), a small papillary structure which is so slightly elevated as to measure only 0.02 *mm.* in height. On the apex and around the small aperture of the subdermal gland, there occur in the papilla-wall a few chitinous granules disposed in a small ring.

The longitudinal musculature of the body-wall is divided into 20–30, separate but anastomosing bundles. The retractor muscles are represented by the ventral pair only, the dorsal pair being wanting. The ventral retractors (*vm*, Fig. 62) spring from the middle of the body proper. The dorsal vessel, running along the dorsal side of the œsophagus, is not provided with contractile villi. The intestinal convolution (*ic*) consists of 10 double spirals around the spindle-muscle, which is fixed at both ends to the body-wall. There is only a single fixing muscle (*fm*), which, arising on the left of the nerve-cord, attaches itself to the first spiral. The rectum is tolerably long; it is without a rectal diverticulum. The segmental organs (*so*) are about half as long as the body proper; their external apertures are situated at nearly the same level as the anus. The organs, for the greater part of their length, are connected with the body-wall by a mesentery. The tentacles are about 22 in number; they are relatively short and finger-shaped.

According to SELENKA'S Monograph, there should be known only one species belonging to the genus *Phymosoma*, viz., *Ph. Rüppelli* GRUBE, that is characterised by having hooks and only two retractor muscles. In these respects the present species agrees with *Ph. Rüppelli*, but in the form and structure of the papillæ, in the number of tentacles, etc., it differs from it sufficiently to justify specific distinction.

Habitat: Naha on Okinawashima (one of the Islands of Riukiu), among dead coral masses.

Genus SIPUNCULUS.

SIPUNCULUS NUDUS, LINNÉ.

SELENKA, (28), 1884, *p.* 92.

The main characters of this species are as follows:

Specimens from the Mediterranean Sea, according to GRUBE, may be 2 feet in length, about 8 inches of which appertain to the introvert. The latter is covered with an immense number of large and very high papillæ. The body proper shows on the surface 30–33, mostly 32, longitudinal grooves, which by intersecting the numerous circular grooves form small rectangular areas. The mouth is surrounded by a tentacular membrane which is divided into the dorsal and the ventral lobe, the former being subdivided into large and the latter into small folds—the tentacular flaps.

The longitudinal muscles are divided into 30–33 bundles which very rarely anastomose. Four retractor muscles arise at the same level from the 4th—8th longitudinal muscles. On the rectum are found a small diverticulum and two glandular structures, the “büschelförmige Körper.” The spindle-muscle arises slightly in front of the anus, and is posteriorly free from the

body-wall. Very numerous fixing muscles are attached to the intestine. Segmental organs are so long that their posterior ends reach the roots of the retractor muscles; the anterior one-fifth of their length is fixed to the body-wall by means of mesenteries. Their external opening lies between the 4th and the 5th longitudinal muscle. Eye-spot absent.

Specimens of this species are frequently obtained in the muddy inlets near the Misaki Marine Laboratory. They are very common along the muddy shores of Tateyama (Province of Bōshyū) and of many localities along the Inland Sea. I have had the opportunity of comparing the Japanese specimens with two well preserved specimens of the same species from Naples. In external as well as internal aspects the Japanese specimens agree well with SELENKA's description, except in the number of the longitudinal muscles of the body-wall. In the Mediterranean specimens the said muscles are, as was pointed out by SELENKA, 32 in number, while in the Japanese forms they number constantly 30.

SIPUNCULUS CUMANENSIS, KEFERSTEIN.

(Fig. 63).

SELENKA, (28), 1884, p. 104.

The main characters of this species may briefly be stated as follows :

Body large, elongate; introvert about one-third of the total length. Skin thick, quite opaque, yellowish or reddish brown in

color. Skin-bodies small and flat, containing a few hook-like structures (?) with the points directed outwards. At introvert-basis and near the posterior end of body, the skin-bodies though but slightly elevated above the surface are so large (0.38–0.4 *mm.* in diameter) as to be easily recognized with the naked eye.

Longitudinal muscles average 20 in number; they are broad and anastomose but rarely. Circular muscles are likewise divided into distinct but narrower bundles. Four retractor muscles arise a short distance behind the anus, the ventral pair between the 7th and the 8th longitudinal muscle. Rectal diverticulum present. Spindle-muscle fixed to the body-wall at both its ends, anteriorly giving off two lateral branches. The single fixing muscle has two roots. Dorsal vessel with numerous but short contractile villi. Segmental organs short, connected with the body-wall for the anterior one-fourth of their length by a mesentery; their external apertures lie between the 3rd and 4th longitudinal muscle. A large number of crescent-shaped dissepiments are present on the inside of body-wall in the region between the anus and the posterior body-end.

This cosmopolitan species is very widely distributed in Japan. Numerous specimens have been obtained from various localities; as for instance, Kamo (Province of Rikuzen); coasts of the Tokyo and Sagami Bays and of the Inland sea; Kagoshima (Kiusiu); Koniya in Amami-Ōshima; Naha and Itoman (Riukiu). The specimens from various localities in Japan proper, including those from Kagoshima, are 20–30 *cm.* in total length and 8–12 *mm.* in breadth, the introvert and the body proper being nearly uniformly broad. The color is yellowish brown in the male and reddish brown in the female. On the other hand, the specimens

from Naha and Koniya are much smaller, while the body-wall, which is rough on the surface, is thicker and more deeply brown in color, without however showing any recognizable difference in internal anatomy. But as compared with foreign specimens, all the Japanese forms seem to show some points of structural deviation as will be gleaned from the following account.

The longitudinal muscles are divided into 18–21 (mostly 20) separate bundles which very rarely anastomose with one another; the circular muscles are also separated into more or less regular bundles. Of the four retractor muscles, the dorsal pair arise from the 7th–9th longitudinal muscles; the ventral pair from the 1st–4th (mostly the 1st–2nd). The roots of all these muscles are situated nearly at the same level. The two lateral branches of the spindle-muscle are attached to the 9th or the 10th longitudinal muscle, close to the root of the dorsal retractor muscle; the main bundle does not end posteriorly in a single root but divides into 3–5 branches which give off still finer ones in order to join the body-wall.

The ‘Ovale Gebilde’ which was first described by KEFERSTEIN from German specimens, is present also in all the Japanese specimens I have dissected. As was already noticed by other authors, these structures are seen as small oblong bodies closely adhering to the inner surface of the body-wall. Their longer diameter measures 0.5 mm. on an average. Sometimes they are found lying on the longitudinal muscles and sometimes between them. They are most abundant in the anal region. When seen in the fresh state, they appear as colorless transparent spots. A study of the bodies on sections has revealed the fact that they are of quite a different structure from those which were described by KEFERSTEIN. According to that author, the bodies should present an appearance of skin papillæ and should inclose a peculiar kind of hook, 0.08–

0.10 mm. high and made up of a substance which is not acted upon by acetic acid or soda. Now in the Japanese specimens, neither hook nor any other solid body can be detected in the interior of the organ; the organ is evidently a saccular gland opening by a short narrow duct to the exterior. Fig. 63 represents a portion of a cross-section through the body-wall, passing through one of the organs under consideration. As may be seen from that figure, the organ incloses a cavity and thus represents a thick-walled sac, the wall being composed of two distinct layers. The external layer (*el*) again consists of two layers, the peritoneal covering and a connective-tissue layer, both of which are continuous with the corresponding layers on the inside of the integument. The far thicker internal layer (*gl*) of the organ is formed of an epithelial row of very tall and large cells with granular contents. The granulation of the latter is in some cells coarse, in others much finer. Staining reactions show that the granules are closely allied to mucin. The nucleus is mostly found situated close to the inner end of the cells. The outleading canal of the gland runs through the thick muscular body-wall to open by an external pore. (The section of Fig. 63 did not pass right through the length of the duct lumen, but the course of this duct is partially indicated by its fibrous investment.)*

* Lately I have had the opportunity of reading HERMANN AUGENER's paper "Beiträge zur Kenntniss der Gephyreen" (Berlin, 1903), in which the author gives a detailed account of the histological nature of the "*Ovale Gebilde*" or his "*Keferstein'sche Bläschen*." The author doubts the correctness of Keferstein's representation of the structures as papillary bodies containing hooks. He considers the wall (exclusive of the peritoneal and the connective-tissue covering) of the body as consisting of two cellular layers: an inner layer, directly lining the lumen of the body and showing a distinctly epithelial character, being composed of radially arranged spindle-like cells with similarly shaped nucleus; and an outer layer of a more connective-tissue-like appearance containing large lacunar spaces and spindle-shaped nuclei. As the author himself makes the statements with much reserve, I am led to doubt their validity; probably the appearances described by him were due to some inappropriate methods of preparation. According to my experience, fixing reagents

SIPUNCULUS AMAMIENSIS, N. SP.

(Figs. 64-65).

The species is of a tolerably large size, the body proper measuring 100-120 *mm.* in length and 10-15 *mm.* in thickness and the length of the introvert being about one-fourth that of the body proper. The color is yellowish brown in the body proper, and a deeper brown in the introvert. The skin-surface is rough, especially at the introvert-basis and at the posterior end of the body, both these parts being covered with the largest skin-bodies. In the middle of the main region of the body, the skin-bodies are nearly flat and of a circular form, measuring about 0.075 *mm.* in diameter (Fig. 64). They are each covered with a thick and finely granular chitinous layer of a yellow color. The central part of this covering is occupied by a relatively large, circular and colorless area which is composed of larger, closely aggregated chitinous granules. Between the papillæ the chitinous layer of the skin forms irregular and interrupted wrinkle-like folds, which divide the surface into irregular mesh-like areas. Near the anterior end of the introvert, immediately behind the tentacles, the chitin folds wholly disappear, and instead of them there appear narrow grooves intersecting one another at right angles so as to bring about a tessellated pattern.

make the structure in question much too hard and brittle for the preparation of good sections. However that may be, I have no doubt that the two layers described by AUGENER collectively correspond to the single epithelial layer I have seen and the glandular nature of which seems to be plain from the reaction shown by the granular contents of the cells towards stains.

As to the physiological significance of the bodies, AUGENER too has suggested the view that they may be regarded as "drüsenartige Gebilde" (p. 63), though this was not proved by him from the histological standpoint.

No hook or spine is present on the introvert. The tentacles are filamentous and about 80 in number; they are arranged in 16 rows, the oral ends of each set of two rows being joined by a U-shaped ridge.

The longitudinal muscles are divided into 15 broad bundles which rarely anastomose with one another in the region of the introvert. Of the four slender retractor muscles, the ventral pair are the larger and spring from the 2nd—3rd longitudinal muscles in the middle region of the body proper, while the dorsal pair arise far more anteriorly from the fourth longitudinal muscles on both sides (Fig. 65, *vm* and *dm*). The dorsal vessel (*dv*) is seen running along the whole posterior course of the œsophagus and gives off very numerous short contractile villi. The spindle-muscle (*sm*), fixed at both ends to the body-wall, gives off two lateral branches (*sm'*) at the very beginning of the intestinal convolution. These branches end on the 6th longitudinal muscles, nearly at the same level as the roots of the dorsal retractor muscles (*dm*). There are, besides, two stout fixing muscles (*fm*): one arises from the 4th longitudinal muscle, close to the roots of the right retractor, and is attached to the beginning of the rectum; the other springs with two roots from the first longitudinal muscle and is attached to the œsophagus near the intestinal convolution. The segmental organs (*so*) are small sacs of a deep reddish brown color; the external apertures lie at the same level as the anus. The organs are entirely free of a mesentery. On the dorsal lip of the funnel or the internal opening, we constantly see two or more small processes, some of which may subdivide into 2 or 3 branches. They seem to be made up simply of the connective-tissue and of the external peritoneal covering. I am at present unable to make any sug-

gestion as to the physiological nature of the structure. There is no rectal diverticulum. Nor is there an eye-spot present on the ganglion.

The present species seems to be most nearly allied to *Sipunculus rotumanus* SHIPLEY and *S. funafuti* SHIPLEY (32). But those two species may both be distinguished from the present by the peculiar form and color of their papillæ as well as by the absence of fixing muscles. Besides, *S. funafuti* is so peculiar in color and body-form, that it bears no resemblance to the present species in external aspects.

Habitat : Numerous specimens were collected by me, in April 1901, at Koniya (Amami-Ōshima), and a single one at Naha (Okinawashima). All were found near the shore in coral sand.

Genus ASPIDOSIPHON.

ASPIDOSIPHON TRUNCATUS, KEFERSTEIN.

(Figs. 66-67).

SELENKA, (28), 1883, p. 118.

The main characters of this species are indicated in the following extract from SELENKA's description :

Color brown all over, but deeper on the anal and caudal shields, both of which are radially grooved. Papillæ small,

slightly larger in the region of the caudal shield. Very numerous rows of very small hooks with incompletely bifurcated apex and bearing warts ("Runzeln") at base. Small spines are scattered to a wide extent behind the hook-rows. Longitudinal muscles partially divided into irregular, frequently anastomosing bundles, which are however more or less regularly developed on the inside of the anal shield. Retractor muscles spring with two roots from the inside of the caudal shield. Intestinal double spirals are traversed by a spindle-muscle fixed at both ends to the body-wall. Rectal diverticulum distinct. Segmental organs long and large, attached to the body-wall by mesenteries throughout nearly their entire length.

Several specimens of this species were collected by MR. MIYAJIMA (1900) and by myself (1901) in Okinawashima (Naha) and Amami-Ōshima (Koniya). The largest specimens in the fully extended state measure 5 *cm.* in total length. In the preserved state, the larger ones have a yellowish brown color and the smaller a light reddish yellow color. The anal and caudal shields are of a deep brown.

The external features and the anatomical characters agree well with the description given by SELENKA. What slight differences seem to exist, are as follows:

On the concave side of the hook, just at the base of the small accessory tooth, a few very fine, thread-like processes of chitin are produced inwards from the spot mentioned (Fig. 66). Between hook-rows there are scattered small tubular papillæ (Fig. 67). Each papilla rests on a low basal prominence which is covered with relatively large chitinous granules (*x*).

The worms live in dead coral masses or in eroded coral rocks.

ASPIDOSIPHON STEENSTRUPII, DIESING.

SELENKA (28), 1883, *p.* 116.

The main characters of this species, taken from SELENKA's description, are as follows :

Introvert and body proper nearly equally long. Color light yellowish brown, nearly black at both ends of body proper. Skin-bodies formed of closely aggregated polygonal plates, four or more of which lie in the center; each of the latter plates with a small plate. The two shields are of a nearly flat hemispherical form, lightly grooved radially and circularly; formed of small oval or polygonal bodies, those lying in the periphery being largest. Introvert with small double-toothed hooks arranged in complete rings and with a great number of relatively tall perforated papillæ ("Ausmündungspapillen"). Longitudinal muscle, in the posterior part, separating into about 25, frequently anastomosing bundles; anteriorly these gradually diminish in number till they all coalesce into a continuous layer. Retractor muscles spring from the beginning of the posterior fourth of the body proper, the line of their origin extending from the 3rd to the 7th (sometimes to the 8th) longitudinal muscle. Spindle muscle fixed to body-wall at both ends. Rectal diverticulum present. Fixing muscle said to be absent, except in specimens from the Philippines, from which SELENKA has described a single fixing muscle attached to the 1st or the 2nd intestinal spiral. No contractile villi. Segmental organs long, posteriorly reaching to the roots of the retractor muscles; their anterior

half accompanied by a mesentery. Two eye-spots present on the ganglion.

This species is one of the commonest Sipunculoids met with in the Riukiu and the Amami-Ōshima Islands.

As in the Philippine specimens described by SELENKA, a fixing muscle is distinctly present. But it may be pointed out that unlike them the muscle terminates on the intestine not with one end, but with two branches; one of these is attached to the hindmost part of the œsophagus, while the other is joined to the spindle muscle just at the beginning of the intestinal convolution. The hooks on the introvert are provided with two distinct rows of small warts lying at the hook base. This fact has not been mentioned in the case of foreign specimens of the species.

ASPIDOSIPHON MISAKIENSIS, N. SP.

(Figs. 9, 68-72).

This species is a small form (Fig. 9). The body proper rarely exceeds 20 *mm.* in length and 5 *mm.* in width; the introvert is unusually long, being at least three times as long as the body proper. The color in the fresh state is a light brownish pink, the introvert-basis as well as the anal and caudal shields being shaded a deeper brown. The anal shield is oval in shape and is composed of minute calcareous granules of a deep brown color; only the periphery of this shield exhibits short radial grooves (Fig. 68). In the anal region, the skin is covered with large and closely set papillæ of a deep brown color which are composed

of small granules hardened more or less by the deposition of some calcareous matter. In the middle region of the body proper, the papillæ are nearly flat, measuring 0.15–0.10 *mm.* in diameter. Over their surface there are aggregated numerous irregularly polygonal chitinous plates of various sizes and of a light brownish yellow or true yellow color. One roundish plate in the center is perforated by the opening of the subdermal gland. The caudal shield is of a conical shape and a deep brown color. Like the anal shield, it is constructed of small calcareous granules, and the margin alone is slightly folded radially. Just behind the tentacular region of the introvert, there follow about 35 complete hook-rows. The hook, 0.032 *mm.* high and yellowish brown in color, is supplied with two sharp teeth (Fig. 69). Behind the hook-rows, there are distributed numerous gently curved spines 0.045 *mm.* in height (Fig. 70). The papillæ on the introvert are represented by a small colorless hyaline tube standing on a tubercle-like base (Fig. 71).

The longitudinal muscle in young specimens is quite continuous, while in the adult it is partially divided into indefinite bundles anastomosing very frequently. There are only two retractor muscles, the ventral pair, which arise very close to the caudal shield (*vm*, Fig. 72). For the greater part of their course, they are fused into one band. The dorsal vessel (*dv*) is very short (about 2–3 *mm.* in length) and has no contractile villi. The intestinal convolution (*ic*) consists of irregular and loosely twisted spirals indicating no definite number of turns. The spindle muscle is, fixed to the body-wall at both ends. A small blind sac (*rg*) is attached to the middle part of the long rectum. Only one slender fixing muscle (*fin*) is present, attached to the first spiral of the intestinal convolution at one end and at the other

to a point on the left of the nerve-cord and close to it, far more anteriorly than the root of the retractor muscle on the same side. The segmental organs (*so*) are remarkably long, being equal to two-thirds of the length of the body proper. The organs are fixed throughout their whole length to the body-wall by a mesentery. The tentacles are short and thick, numbering 8-10. Two eye-spots are present on the ganglion.

Among the hitherto known *Aspidosiphon* species, *A. elegans* CHAM. & EISENH. seems to be most closely allied to the present species. However the two species in question may be distinguished from each other by different features of the anal and caudal shields and by the difference in the size and form of the hooks and spines.

Habitat: I have collected the species only at Misaki, along rocky shores in the vicinity of the Marine Laboratory.

ASPIDOSIPHON UNISCUTATUS, N. SP.

(Figs. 10, 73 — 77).

The unique specimen (shown in Fig. 10) on which this species is based, was found in MR. MIYAJIMA'S collection made at Kataura in the province of Satsuma (1900). In its present state, preserved in alcohol, the body proper measures 13.5 *mm.* in length and 3.5 *mm.* in maximum width. The skin, which is relatively thick, is yellowish brown becoming a deeper brown towards the anal shield. The latter, deep reddish brown in color, is of a tall helmet-like shape, obliquely truncated at the

basal border. The wall of this shield is unusually thick and hard on account of the deposition of a calcareous substance. Its surface is sculptured into numerous longitudinal ridges and grooves that converge towards the rounded apex. When examined under a certain magnification, the ridges are seen to be covered with small chitinous bodies of a deep brown color (Fig. 73), and at the hindmost end of each ridge there is situated a large papilla consisting likewise of chitinous bodies similar to those of the remaining part of the ridge. The center of this papilla shows a circular space formed of small and light-colored plates and surrounded by 2-3 rings of very dark-colored plates. The apical parts of the shield are stripped of the epidermis, thus exposing the underlying white calcareous layer. The skin-surface adjacent to the shield is closely beset with papillæ which appear as deep brown spots. These latter are structurally the same as those of the papillæ lying at the basal border of the anal shield, though they are somewhat smaller. In the middle and posterior regions of the body, the papillæ are quite flat, and are formed of many polygonal chitinous plates separated from one another by narrow grooves (Fig. 74). These plates are smaller towards the center of the papilla, where the pore of the subdermal gland is situated. The caudal shield is not definitely marked off, but is simply indicated by a darker brown color. The aperture of the introvert lies just below the ventral border of the anal shield, so that the introvert as a whole stands out nearly at right angle from the body proper. The introvert is about as long as the body proper, and is of a light yellowish brown color. The anterior portion carries numerous complete ring-rows of hooks which are 0.04 *mm.* long and of a reddish yellow color (Fig. 75). Between these rows are scattered tubular papillæ

(Fig. 76) which are hyaline and colorless and measure about 0.015 *mm.* in height.

The longitudinal muscle is, in the middle of the main part of the body, divided into frequently anastomosing bundles, but is quite continuous in the region of the introvert-basis and in the posterior fourth of the body proper. The sexual organs (*sx*, Fig. 77) are developed as two slender wavy bands at the roots of the retractor muscles (*vm*). The intestinal convolution (*ic*) consists of about 12 spirals, and is traversed by the spindle muscle (*sm*) which is fixed to the body-wall at both ends. There is no fixing muscle at all. The blind diverticulum (*rg*) is attached to the middle part of the rectum. The segmental organs (*so*) are in length equal to about two-thirds of the body proper, and are of a pale reddish brown color. The organs are for the whole length accompanied by a mesentery. Their external apertures are situated at the same level as the anus (*a*). The anterior terminal portion of the rectum is provided with well-developed wing-muscles (*wm*). Two brown eye-spots on the ganglion (*g*). Tentacles short, 10 in number.

Habitat: Kataura in the province of Satsuma. The worm was found in a small hole bored through a small piece of dead coral.

ASPIDOSIPHON ANGULATUS, N. SP.

(Figs. 11, 78-80)

Only one specimen of this species has been collected by me (1901) in the Inlet of Katsuyoki in the Amami-Oshima Island. It lived in a dead coral that was exposed at low tide. The

animal (Fig. 11) is small, measuring 15 *mm.* in length of the body proper. The introvert is nearly as long as the body proper, but only half as thick. The skin is very thin, smooth, partly transparent and of a light reddish brown except at the anterior end of the body proper, where it is a deeper brown and of a rough granular appearance. The anal shield may be said to consist of an obliquely conical main part and of a short, cylindrical, basal part. The former has the surface marked with distinct radial grooves. The basal part also shows grooves which alternate in position with those in the conical part (see Fig. 11). The entire shield is formed of small, densely aggregated chitinous plates. The caudal shield is in the shape of two cones juxtaposed at base; it is radially grooved, the grooves on the two cones alternating (see the above figure). The greater part of the body proper shows no papillary structure; only by using a high power of the microscope can the numberless small openings of the subdermal glands be discovered. Just in front of the caudal shield there are seen some slightly prominent papillary bodies measuring 0.06–0.10 *mm.* in diameter. They are formed of small polygonal chitinous plates of a light yellowish brown color (Fig. 78). The plates are somewhat smaller in the central part of the papilla than in the periphery; the most centrally situated plate bears the pore of the subdermal gland. Around the base of the anal shield, the papillæ are larger (commonly 0.10 *mm.* in diameter) and of a deeper brown than in the posterior region. Very numerous hook-rows are present on the introvert surface. The hooks (Fig. 79), 0.02 *mm.* high on an average, have a bluntly pointed apex; they are of a light yellow color. Between these hook-rows there are distributed small tubular papillæ. No spines can be detected behind the hook-rows.

The longitudinal muscles are incompletely divided into frequently anastomosing bundles. Two retractor muscles, the ventral pair (*vm*), arise slightly behind the middle of the body (Fig. 80 Pl. IV). The sexual organs (*so*) are situated at a short distance behind the roots of these muscles. The intestine is convoluted into about 15 spirals. The spindle muscle (*sm*) is fixed to the body-wall at both ends. No fixing muscle and no rectal diverticulum are present. Peculiar to this species is the fact that the oesophagus (*os*) is attached to the retractor muscle at a point so far from the fusing point of the right and left retractors, that it appears to be entirely free from the muscle. The segmental organs (*so*) are about one-third as long as the body proper; their posterior halves are free of the mesentery joining them to the body-wall. On the dorsal lip of the internal opening or funnel, there is present a very small sac-like body. Eye-spots cannot be discovered. The filamentous tentacles are probably 10 in number.

ASPIDOSIPHON SPINALIS, N. SP.

(Figs. 12, 81-85)

The animals (Fig. 12) belonging to this new species are of small size, the body proper being generally about 10-15 *mm.* long (28 *mm.* in one specimen) and about 3 *mm.* in breadth. The skin appears smooth, and has a light yellowish brown color in the main part of the body proper, but is rough and of a deeper brown on the anal shield and the dorsal side of the introvert.

As in *Aspidosiphon angulatus*, no distinct papilla or skin-body is present, except the small pores of the subdermal glands. The anal shield is an elliptical and nearly flat body, covered with large brown papillæ. These are composed of minute chitinous granules. The caudal shield is not so thick, nor so distinctly contoured as the anal shield. Its peripheral portion alone is marked with small chitinous granules of a brown color. Confined to the vicinity of the two shields, are the papillary bodies; they are very slightly elevated, elliptical in form, brownish in color, and measure on an average 0.15 mm. by 0.09 mm. in the two diameters. The papillæ (Fig. 81, Pl. III) show the same structure as those of *Aspidosiphon angulatus*, except in the one unimportant respect that the chitinous plates are in general larger than in that species. The introvert is nearly as long as the body proper; its posterior half is deep brown on account of the presence of spines of that color. The spines (Fig. 82) are straight, sharply pointed, broad at base and are formed of a thin chitinous lamina folded in a funnel-like manner; they are 0.04 mm. high in the anterior region, but become gradually taller towards the introvert-basis where they measure 0.07 mm. in height. These spines are distributed over almost the whole surface of the introvert, but are most closely aggregated on the dorsal side of the posterior half of the part, thus giving to this region a deeper brown color than elsewhere. In the anteriormost parts of the introvert, there are found numerous complete rows of brown colored hooks. The hook (Fig. 83) is 0.05 mm. high and is provided with two sharp teeth at apex. In the interspaces between hook-rows there occur small colorless and transparent tubular papillæ (Fig. 84) about 0.03 mm. high.

The longitudinal muscles are entirely continuous. The two

(ventral) retractor muscles (*vm*, Fig. 85) arise just in front of the caudal shield. The intestinal convolution (*ic*) consists of 10–15 spirals, traversed by the spindle muscle (*sm*), which is fixed to the body-wall at both ends. No fixing muscle is present. The rectum is long and lacks a diverticulum. The anus is situated just behind the anal shield. The two segmental organs (*so*) of a reddish brown are about as long as the body proper and are fixed to the body-wall by a mesentery along their entire length. Their external apertures lie a short distance behind the anus. The two eye-spots appear as brown specks on the ganglion.

Habitat: Numerous specimens of this species were found (April 1901) in dead corals, at Koniya in Amami-Ōshima Island.

Genus CLÆOSIPHON.

CLÆOSIPHON JAPONICUM, N. SP.

(Figs. 13, 86–89).

This species is one of the commonest Sipunculoids met with in the Riukiu and Amami-Ōshima Islands. The general external and internal characters seem at first glance to agree well with those of *Clæosiphon aspergillum* QUATREFAGES, *C. mollis* SELENKA & BÜLOW or *C. javanicum* SLUITER, but careful examinations bring to light some important points characteristic of each of the

species mentioned, especially in regard to their external features. As to its internal characters, the present species may be said to be almost identical with *C. aspergillum* and *C. javanicum*, except in the facts that the longitudinal muscle is not separated into bundles and that the sexual organs are not developed in the same position as in *C. javanicum*.

The species has long cylindrical body which may reach about 7 *cm.* in length and 7 *mm.* in width. The posterior end of the body is rounded in the fresh state. As was noticed by SHIPLEY (31) in *C. javanicum*, the external appearance of the species is subject to considerable individual variation, but as a general rule two types of characters are distinguishable. In the one the skin is thick and of a deep brown and the calcareous shield, composed of calcareous papillæ, is as wide as the body proper; while in the other the skin is thin, nearly transparent and of a reddish brown and the shield, consisting of very small papillæ, is narrower than the body proper. According to my own observations, however, these differences are in a great measure those of the sex. The first type referred to being seen mostly in the male and the second in the female. Fig. 13 is taken from a large male in the living state.

The anal shield, which shows a structure peculiar to the genus, presents varying shapes according to the state of contraction, a fact previously noted by SLUITER (35) in *C. javanicum*; it assumes all sorts of forms varying from that of a depressed disc to that of a cone. The shield is made up of numerous milky-white calcareous papillæ which are spirally arranged and become gradually smaller towards the posterior border (Fig. 86). The papillæ are mostly of a hexahedric form, but their external facets present rather irregular shapes, being quadrate, rhomboidal,

pentagonal and rarely polygonal. A condition similar to the above has also been noticed by SELENKA (28) in *C. mollis*. The edges of the external facets are not sharp, but bevelled and are pigmented a deep brown in the fresh state. The center of each external facet, which is perfectly flat, is occupied by a small, deep brown, circular pore of the underlying papillary gland. Skin-papillæ are scattered over the entire surface of the body proper, and are so large that they may be detected with the naked eye; they are especially densely aggregated near the base of the shield. Under the microscope each papilla appears as a slightly prominent body of a brown or yellowish brown color. Its peripheral portion is formed of two irregular but concentric rings of small chitinous plates, while the central portion is roofed by a thin chitinous layer which is often incomplete as shown in Fig. 87. The subdermal gland opens at the center of the papillæ. The papillæ measure, in the middle region of the body proper, about 0.08 mm. in diameter. They become gradually shorter but stouter towards the posterior end, while on the other hand they become taller and more slender towards the base of the calcareous shield. On the introvert-basis, they are remarkably tall, measuring 0.10 mm. in average height; they appear as cylindrical protuberances of a coarsely granular appearance (Fig. 88). Chitinous granules are distributed also over the non-papillated part of the skin. There are present about 20–25 complete ring-rows of hooks. These are 0.10 mm. high and of a brown color, and are provided with two sharp curved teeth (Fig. 89). As was figured by SLUITER from *C. javanicum*, there are a few small processes situated just below and inside the accessory tooth. At the hook-basis there lie two small transverse bars and two rows of warts (see the above figure). In the interspaces between hook-rows there

are distributed numerous tubular or perforated papillæ (Fig. 89); the upper or free edge of these is guarded by a row of very small chitinous teeth.

In the individuals which I regard as the female, not only the shield itself, but also the calcareous papillæ on it, are much smaller than in those which I regard as the male. Besides, in the former case all the papillæ are nearly of the same size. Some individuals are characterised by a peculiarly modified shield; the calcareous papillæ found at the apex of such shields are elongated into long processes of a deep brown color. Quite a similar feature was described by SLUITER in connexion with the shield of *C. javanicum*.

Cleosiphon japonicum must be regarded as a distinct species differing in several important points from the hitherto known species, viz., *C. aspergillum*, *C. mollis* and *C. javanicum*. It differs from *C. aspergillum* in the irregular forms of its calcareous papillæ, in the structure of its skin-papillæ (of the introvert-basis as well as of the body proper) and in having the warts and the perforated papillæ. Neither *C. mollis* nor *C. javanicum* have the two structures last mentioned. *C. mollis* may be distinguished from *C. aspergillum* by the presence of very small hooks and the absence of eye-spots,—points of difference which exist also between *C. mollis* and the present species. Lastly, the differences between *C. javanicum* and the present species are most remarkable; in the former species one edge of the external facet of the calcareous papilla being said to be considerably raised, and the aperture of the papillary gland on the facet, elliptical in shape. Besides these two points, the characteristic broad form of the hooks and the formation of the longitudinal muscles into bundles are quite peculiar to *C. javanicum*.

The internal anatomy of the present species may be briefly outlined as follows :

The longitudinal muscle is quite continuous. The retractor muscle arises with two roots at the beginning of the posterior fifth of the body proper. Double intestinal spirals number about 12. Spindle muscle fixed at both ends. Only one fixing muscle attached to the beginning of rectum. Segmental organs connected with the body-wall along their whole length by mesentery. No rectal gland. Two distinct eye-spots are present on the ganglion.

Genus DENDROSTOMA.

DENDROSTOMA BLANDUM, SELENKA & DE MAN.

(Figs. 14, 90 & 91).

SELENKA, (28), 1883, *p.* 85.

The main characters of this species are summed up in the following extract from SELENKA's description :

Body of a stunted form ; introvert one-third as long as body proper. Color brownish or reddish gray. On the middle region of the introvert are scattered numerous large and sharply pointed black hooks 0.4 *mm.* in height. Papillæ in the middle region of the body proper, low, oval, 0.07–0.09 *mm.* in diameter ; in the

central part of each papilla there is a clear area surrounded by small horny granules. Papillæ on introvert-basis and on the posterior end of body, slightly larger; most prominent just behind the hood-region of introvert. Small papillæ also present in the hooked region of introvert. Tentacles arise from several (5-6) main stems. Two retractor muscles arise from the middle third of the body proper. Two segmental organs about half as long as the body proper; mesentery entirely lacking. Posterior end of spindle muscle not attached to the body-wall. Three fixing muscles; one of them attached to the rectum and the others to the œsophagus. Contractile villi remarkably long, but few in number.

Two alcoholic specimens of this species were found in a zoological collection made in the Hokkaidō in 1900 by MR. IZUKA; one of them is from Wakkanai (near Cape Sōya) and the other from the harbor of Aomori. The latter specimen (Fig. 14) is the better preserved, measuring 2.5 *mm.* in length of the body proper. Both specimens are of a brown color in the preserved state. The introvert-basis shows on the skin-surface fine circular, and somewhat coarser, longitudinal furrows.

As to the skin-structures and the general anatomy, the specimens agree within certain limits with SELENKA's description of *Dendrostoma blandum* which was many years ago obtained by HILGENDORF at Enoshima. But careful studies of my specimens disclose some important points which either were omitted by SELENKA, or are irreconcilable with, his description. However, I do not feel fully justified in establishing a new species on the strength of these apparent differences, since the specimens at my disposal seem too few to be conclusive.

The papillæ of the body proper and of the introvert, are nearly of the same form, size, and structure as in HILGENDORF'S specimens. The scattered hooks also show the same form and color as in those specimens, but are very much smaller (0.20 *mm.* high), being only half as high as HILGENDORF'S (0.40 *mm.*). The tentacles are reddish brown. In my specimens, they are given off from the free margins of the eight arms produced by the dichotomous branching of each of the four main stems (Fig. 90). Some few short tentacles are also present along the inner margin of each main stem. The above mode of branching of the tentacular stems is not described by SELENKA, who on the other hand states that the main stems are 5 or 6 in number.

In one specimen—that from Aomori—there are four fixing muscles to the intestine, two on each side of the nerve-cord. On either side, one muscle is attached to the œsophagus near the posterior extremity of the dorsal vessel and the other to the first intestinal spiral; both arise from the body-wall close to each other, far in front of the roots of the retractor muscles and widely separated from the ventral nerve-cord. In the other specimen—that from Wakkanai—one of the fixing muscles of the left side is wanting, the single muscle present on that side dividing into two short branches (Fig. 91). Both of the latter are attached to the first spiral of the intestinal convolution (one to the œsophageal, and the other to the rectal, section of the intestine. Close to the entrance to the convolution, there is present on the rectum a distinct blind diverticulum (*rg*, Fig. 91), an organ which has not been mentioned by SELENKA from HILGENDORF'S specimens. The fixing muscles are stated by SELENKA to be only two in number.

DENDROSTOMA SIGNIFER, SELENKA & DE MAN.

(Fig. 15).

SELENKA, (28), 1884, *p.* 86.

The main features of the species are embodied in the following extract from SELENKA :

Body of a stunted form, tapering posteriorly to a sharp point; introvert about one-fourth as long as the body proper. Color brownish or yellowish red, with a dark blue band at the middle of the introvert. Skin-bodies very small (0.06 *mm.* in diameter), quite flat; represented by oval areas, from the center of which a narrow canal leads down to the granular layer below. Hooks generally wanting. Tentacles very numerous, springing from 5 or 6 main stems. Eye-spots present.

Longitudinal muscle continuous. Two strong (ventral) retractor muscles arise from the beginning of the posterior third of the body proper. Intestinal spirals 15–20 in number, traversed by a spindle muscle not fixed to the body-wall at its posterior end. Three fixing muscles: one attached to rectum and two to œsophagus. Contractile villi very numerous, long, and branching.

Four specimens (Fig. 15) of the above species were collected in the Riukiu Islands. They were found in holes bored through dead corals. All measure about 30 *mm.* in total length. They tally well with SELENKA's description of the Phillippine specimens,

except in the facts that the main tentacular stems are constantly four in number (instead of 5 or 6) and that the hooks are entirely wanting in all the specimens. There occurs on the rectum a distinct blind diverticulum such as has not been noticed in any species of *Dendrostoma* yet described.

DENDROSTOMA MINOR, N. SP.

(Figs. 16, 92-95).

This species is a small form, not exceeding 15 *mm.* in length and 3 *mm.* in breadth. The introvert is one-third as long as the body proper. The worms in the fresh state are of a yellowish brown color, only the anterior portion of the introvert being of a light violet tint. The whole surface of the skin is covered with small papillæ which are nearly flat in the middle main region of the body proper. But in the anterior and posterior regions, the papillæ are somewhat raised and appear as oval tubercles of 0.02-0.03 *mm.* height and 0.10 *mm.* long diameter (Fig. 92). They are formed of numerous polygonal chitinous plates which are larger towards the center of the papillæ; one plate in the center contains the opening of the subdermal gland. In the hooked region of the introvert, the papillæ are much smaller, but are of nearly the same height, appearing like a hemispherical tubercle resting upon a broader basal elevation (Fig. 93). Hooks, about 50 in number, are found scattered in the anterior parts of the introvert (Fig. 94). They are 0.04 *mm.* high, blackish brown in color, slightly curved and bluntly pointed at apex. Specimens from Funakawa in the province of Ugo (on

the Japan Sea) differ from those from other localities in having fewer but larger hooks, 20–30 in number and about 0.06 *mm.* in height. The tentacles are given off from four stems: these latter split each into two branches; each branch again divides into 4–6 long tentacles which are of a violet color except at the bright yellow tip.

The longitudinal muscle is continuous. There exists only one pair of retractor muscles (the ventral), originating in the middle of the body proper or at a somewhat more posterior point. The dorsal vessel, running along the dorsal side of the œsophagus, bears numerous, tolerably long, contractile villi (*cv*, Fig. 95). The intestinal convolution, consisting of 7–12 spirals, is loose and irregular, especially in young specimens. The spindle muscle is not attached to the body proper at the posterior end of the body. The rectal portion of the intestine is tolerably long and bears at its beginning a small blind diverticulum (*rg*). Of fixing muscles there are present sometimes two, sometimes only one and in still other specimens, none at all. When present in a pair, both are attached to the first intestinal spiral and end on both sides of the nerve-cord; when present singly, the muscle is on the left side. The segmental organs (*so*) are about one-third as long as the body proper, and are entirely devoid of a mesentery. Their external apertures lie at the same level as the anus. Eye-spots are present on the ganglion.

The present species in the manner of the branching of its tentacles and in their color resembles *Dendrostoma alutaceum* GRUBE, but is quite different from that species in the form, size, and structure of the papillæ, in the size of the hooks, in the number of contractile villi and in the total size of the worm-body.

Habitat: Specimens of the species have been collected at

Funakawa in the Province of Ugo, Misaki, Habu on Ōshima (Izu Province), and Tanegashima, a small island near Kagoshima. The species lives under algæ covering rocks along the tide-marks

ECHIUROIDEA.

Genus ECHIURUS.

ECHIURUS UNICINCTUS, VON DRASCHE.

SELENKA (29), 1885, *p.* 385.

RIETSCH (26), 1886, *p.* 188.

SHIPLEY (31), 1899, *p.* 344.

EMBLETON (8), 1900, *p.* 77.

SHIPLEY's diagnosis runs as follows:

"Length of body averages 8.5 *cm.*; length of proboscis, 5–6 *mm.* when contracted. Color, bright yellowish brown. Papillæ uniform in size, only arranged in transverse rows in special places, *e.g.*, near the hooks. Single circlet of bristles, usually 11, but any number from 9–13 has been found. Circular muscles consist of 200 bundles frequently anastomosing. Nephridia, two pairs, with spirally coiled internal openings."

This species is the most abundant Echiuroid in Japan, and is the only representative of the genus in this part of the world. The worms are known to live in shallow sandy inlets along the

Pacific coasts of Japan proper, south of the Tokyo Bay. As far as I know, they are exceedingly abundant in shallow parts of that bay, for instance, at Inage (Province of Shimosa), Haneda (Province of Musashi), and at Tateyama (Bōshū). From the last mentioned locality specimens of a large size (25 *cm.* or even 30 *cm.* in length and 3–4 *cm.* in breadth) have been obtained. Tomo (Bingo) and Hiroshima on the Inland Sea may also be mentioned as localities where this species is known to occur in great abundance.

As to the systematic characters and the microscopical anatomy of the species I have nothing to add to the exact and detailed studies of SELENKA and EMBLETON. Of much interest to me is the observation by the latter author that in the present species there is no true vascular canal at all—a fact which I have also observed independently.

Genus **THALASSEMA.**

THALASSEMA KOKOTONIENSE, FISCHER. (?)

(Fig. 17).

FISCHER (9), 1892, *p.* 2.

SHIPLEY (34), 1899, *p.* 337.

During a trip in 1901 to the Amami-Ōshima and Riukiu Islands, I collected in all 10 specimens which I provisionally

refer to the above species. In the preserved state they present nearly all the essential characters attributed to the species by FISCHER. But in the fresh state the worms were found to be of a characteristic coloration, quite different from that known from typical *T. kokotoniense*. FISCHER's description of the internal anatomy is so brief, that it does not help me much and so I must say I have considerable doubt as to the correctness of my identification of the specimens.

The body in the fresh state attains 6.5 *cm.* in length and 15 *mm.* in width, the proboscis being much shorter and narrower than the body (Fig. 17). The proboscis is straw-coloured, edged with deep green on the free margin; the body is of a grayish yellow color, its posterior end being suffused with green. When the circular muscles contract, there appear a series of longitudinal, deep red, dotted lines over the body-surface (see Fig. 17). The papillæ are larger in the posterior end of the body than in other regions, where they are arranged in transverse rows or rings on the skin.

The longitudinal muscle is always divided into 18 bundles. The segmental organs are present in three pairs; they are colorless and transparent and are all provided with two short spiral lobes. The first pair lie in front of the ventral hooks. The anal glands are one-third as long as the body-length and are fixed at their bases to the body-wall by 4-5 small muscles. Over their whole surface are scattered numerous small funnels which have very short stalks. As has been noted by FISCHER, the terminal part of the rectum bears a large rectal gland which is connected with the ventral nerve-cord by a short delicate mesentery.

Habitat: The species was found burrowing in coral sand at Naze (Amami-Ōshima) and at Naha (Riukiu).

THALASSEMA OWSTONI, N. SP.

(*Thalassema diaphanes* SLUITER.?)

(Figs. 18, 96 & 97).

The single specimen, on which this species is based, was dredged by MR. OWSTON together with the type specimen of *Phascolosoma owstoni*, from a depth of 180 fathoms in the Uraga Channel. It is small, measuring 17 mm. in length and 5 mm. in breadth. The proboscis, about 7.5 mm. long, is deeply furrowed longitudinally. The color, as preserved in formalin, is a pale reddish brown. The skin is soft and smooth, except at both extremities of the body proper, where the papillæ are largest and most closely aggregated. In the main middle region of the body the papillæ cannot be detected with the naked eye. There are two comparatively large ventral hooks of a bright yellow color.

The longitudinal muscles of the body-wall are throughout continuous. Only a pair of small sac-like segmental organs are situated just behind the ventral hooks (Fig. 96, *so*). They have no spiral appendage, but are provided with a large ciliated funnel (Fig. 97, *fn*). The erector (or the radial) muscles of the hooks are well developed (*em*, Fig. 96); the interbasal muscle is very long. Unfortunately the specimen is torn near the posterior end of the body, so that the greater part of the alimentary canal and of the anal glands has been lost. In spite of this defect it can be ascertained that there are present small ciliated funnels

on the last mentioned organs. The funnels are large, situated close together and borne on short stalks. The specimen is a female and the segmental organ of the right side is filled with ripe eggs.

The present species seems, as far as I can judge, to be most closely allied to *Thalassema diaphanes* SLUITER. I regret to say I have been unable to get access to SLUITER's original description of that species.* From what SHIPLEY (34) says of it in his revision of Echiuroids, it seems that the two species agree in having only one pair of segmental organs, in the continuous longitudinal muscle, and in wanting spiral lobes at the internal openings of the segmental organs. But the specimen in my possession shows in other points considerable deviations from SHIPLEY's description (*l.c.*, p. 336 and 346) and figure (*l.c.*, Pl. XXXIII, 2) of *T. diaphanes*, which fact has led me to base a new species on it. The most important points of difference consist in the smaller size of the body, and the thicker body-wall in the present species, and in the manner of distribution of the papillæ.

THALASSEMA TÆNIOIDES, N. SP.

A full description, with figures, of this most remarkable new species has been prepared for publication in a separate paper.† Here only the specific characters will be given in brief.

The species may be said to be of gigantic size, the body proper reaching 40 *cm.* in length and 2–3 *cm.* in breadth, while

* *Naturk. Tijdsch. Nederl. Ind.*, Vol., XLVIII, 1888.

† "On Three New and Remarkable Species of Echiuroids," soon to appear in this Journal.

the proboscis, when fully extended, is as long as 100–150 *cm.* The body proper is of a deep reddish brown color; the proboscis bears narrow transverse stripes of brown. The papillæ are irregular in shape, and are largest and most closely crowded together at both ends of the body proper. The ventral hooks are relatively small and brownish yellow in color. In the fresh state, there are seen on the body proper five narrow longitudinal stripes of a pale yellow color, corresponding to special thickenings of the longitudinal muscle. The bulbous bases of the paired hooks are joined by a slender interbasal muscle. The alimentary canal pursues a course which is peculiar to this species. The pharynx is accompanied by two large wing-like muscles. The anal glands are 6–7 *cm.* long, fixed at the apex by a long muscle; they appear to be hairy on account of the presence of very long funnels. No rectal gland is present. As the heart lies in a very posterior situation, the dorsal vessel is remarkably long. The segmental organs are extremely abundant; in the larger specimens, they may number not less than 200 on one side of the ventral nerve-cord, arranged not in pairs but apparently without order. They are small, measuring 10–12 *mm.* in length; the internal opening is terminal in position.

Habitat: The species inhabits shallow muddy bottoms in deep vertical holes, from the opening of which the long worm-like proboscis is extruded. It has hitherto been obtained at Tsushima; Bay of Amakusa (Kiushiū); Tomo and many other localities in the Inland Sea; Tateyama (Bōshiū); Haneda (Tokyo Bay); and Misaki. In the last locality the species is common.

THALASSEMA ELEGANS, N. SP.

This highly interesting species will also be fully described in a separate paper together with the preceding. Here I restrict myself to giving only the most salient characters of the species.

Externally the species looks very much alike *Thalassema tænioides*, though there exist remarkable differences in internal structure. In size, shape and color it shows a far reaching agreement with that species except as regards the proboscis. This in the present species is 30–40 *cm.* long and 1.7–2 *cm.* wide, and is of a bright yellow color which becomes deeper towards the mouth. The ventral surface of its anterior portion, for a length of 6–7 *cm.* is marked with a fine and irregular net-work of a bright green color. As in *T. tænioides*, there are found on the body-surface longitudinal stripes of a pale yellow color, which however number 10, instead of 5. The ventral hooks show nearly the same size, form, color and position as those of *T. tænioides*; but internally they are not joined by an interbasal muscle. The circular muscle of the body-wall is separated into more or less regular bundles. The segmental organs are numerous (in one specimen 27 were counted) and are distributed generally in groups of which there are 7 pairs, each consisting of 1–3 segmental organs. Aside from the pairwise arrangement indicated, there seems to obtain no definite order in the manner of the occurrence of single segmental organs. They represent large elongate sacs, each bearing two comparatively short spiral lobes. The pharynx is joined to the body-

wall, but is not accompanied by a mesenterial muscle. The anal glands are long slender tubes, about 20 *cm.* in length, and are provided with small, short-stalked funnels. No rectal gland is present.

Habitat: The species inhabits shallow muddy bottoms, in deep, somewhat obliquely sunk pits. It occurs together with *T. tænioides* in the inlet of Moroiso, close to the Misaki Marine Laboratory.

THALASSEMA GOGOSHIMENSE, N. SP.

(Fig. 19).

The present species (Fig. 19) most closely resembles *Thalassema mucosum* both in color and external shape, with the exception of the facts that the body is much larger and the papillary spots more deeply colored with a dirty green pigment. The dorsal surface of the proboscis is covered with small green spots, while its free margin is colored yellow. The total length is, in the fully extended state, about 15 *cm.* of which 10.5 *cm.* appertain to the proboscis; the maximum width, about 2 *cm.* Over the surface there are closely strewn moderately large papillæ which are slightly larger and more crowded towards both extremities of the body proper. The two ventral hooks of a golden yellow color are found in the usual situation just behind the mouth.

In spite of its external resemblance, however, this species differs remarkably from *Thalassema mucosum* in internal anatomy. In this respect it shows, contrary to expectation, an essential agreement with *Thalassema elegans*. Indeed, the agreement may be said to be complete, the only difference being that all the visceral organs in the present species are developed on a smaller scale in proportion to the smaller size of its body. It therefore seems unnecessary to give a description of the anatomy. However, certain points with regard to the segmental organs of the species require special mention. In the females, the said organs as far as they have come under my observation, are invariably present in three pairs, all situated behind the ventral hooks. On the other hand, the males show these organs in varying numbers and arrangement, a fact which seems to be of interest in relation to the polynephridism I have observed in *T. tænioides* and *T. elegans*. In one male specimen of the species I have found them in eight groups arranged pairwise, each group consisting of four organs, making thirty-two in all. In some other male individuals, the organs were present in three paired groups, some of which comprised four and others only one or two organs. As to the shape of the organs in question, there exists scarcely any difference from those of *T. elegans*.

Habitat: I have found the species very common in the shallow waters around the islet of Gogoshima (Province of Iyo). The presence of the worms is indicated by the large and peculiarly shaped faecal masses scattered around small elevations of the bottom exposed at low tide. Lately I was presented by MR. IZUKA with a specimen of this species which he obtained in the inlet of Moroiso near the Misaki Marine Laboratory.

THALASSEMA MUCOSUM, N. SP.

(Figs. 20 & 98).

Three specimens of this new species have been obtained from the muddy shore of Moroiso near the Misaki Marine Laboratory.

The cylindrical body in the live state reaches 7 *cm.* in length and 1.8 *cm.* in width; the tubular proboscis is much shorter and narrower, and has a truncated apex. The body-wall is thin and is of a light green color, which becomes deeper at both extremities and also along the margins of the proboscis. The papillæ, large enough to be visible with the naked eye, are also deep green; they are closely aggregated, especially at both ends of the body proper. In the fresh state, the body-surface always appears dirty owing to thick mucous spread over it. The two ventral hooks are small, slightly recurved and bright yellow in color. They are provided with rather short radial muscles (*em*, Fig. 98), but are devoid of an interbasal muscle. The longitudinal and circular layers of the dermal musculature are not divided into separate bundles. There are three pairs of comparatively short small segmental organs (*sg*), all of which lie behind the ventral hooks and have long spiral lobes. The pharynx (*ph*) is accompanied by two weakly developed mesenteries (*wm*) arising from the body-wall, close to the nerve-cord. The mesentery on the right side is much longer than that on the left. The neuro-intestinal vessel (*ni*), instead of being

single, appears as two vessels, which unite into one to communicate with the ventral vessel. There are two long anal glands, the anterior ends of which extend to the middle of the body; a few fine muscular strands join their posterior portions to the body-wall. The ciliated funnels of these glands are small, their stalks being very short. No rectal gland is present.

This species seems to be closely allied to both *Thalassema vegrande* LAMPERT and *T. Mæbii* GREEFF, as judged from the agreement in internal structure, but it may readily be distinguished from either. Unlike the present species, *T. vegrande* is said to be without proboscis and also without funnels on the anal glands. Of the proboscis, SHIPLEY (32) says: "Like LAMPERT I had only a single specimen, and, like his, mine had no proboscis. There was no trace of one and no scar to indicate that there had ever been one, and I am inclined to think that this species may be without a proboscis."

In contrast with *Thalassema Mæbii* the present species exhibits considerable difference in external features as a comparison of GREEFF'S (14) figure of the former with mine of the latter (Fig. 20) will show. The differences mostly concern the size, form and coloration of the proboscis as well as of the body proper.

THALASSEMA FUSCUM, N. SP.

(Figs. 21 & 99).

In external features the present species closely resembles *Thalassema mucosum*, except in color. The long cylindrical body proper is about 7.5 cm. long and 15-18 mm. thick, while

the proboscis is about 2 *cm.* long and truncated at the apex. The skin is of a slightly pinkish orange-yellow which becomes reddish on the edges of the proboscis. Large papillæ are scattered irregularly over the entire body-surface, more thickly at both ends than in the middle. The two golden-yellow ventral hooks are relatively small in size and are supplied with well developed radial muscles (*em*, Fig. 99). The longitudinal dermal muscle is perfectly continuous. There exists only one pair of comparatively long (about 20 *mm.*) segmental organs (*so*), attached to the body-wall just behind the ventral hooks. The opening of the organs appears as a large funnel (*fn*) unprovided with spiral lobes. The pharynx as well as the œsophagus are entirely without a mesentery or muscular strands. The anal glands are about as long as the body proper; the ciliated funnels, sparsely distributed over the surface, are relatively small and short-stalked. No rectal gland is present.

There have hitherto been known four *Thalassema* species which, like the present, have a continuous longitudinal muscle and only one pair of segmental organs, *viz.*, *T. diaphanes* SLUITER, *T. fax* SELENKA, *T. gigas* MÜLLER and *T. Lankesteri* HERDMAN. The first further agrees with the present species in one other point, *viz.*, that the segmental organs lack spiral lobes; nevertheless, the former shows several important characters which are entirely wanting in the latter. Of the three remaining species mentioned, *T. gigas* seems to be nearest to the present species in respect of general internal anatomy; but, that species, as figured and described in detail by GREEFF (14), should be easily distinguishable from the new species here described, owing to the differences in size, color and general features of the entire worm-body.

THALASSEMA INANSENSE, N. SP.

(Figs. 22 & 100).

A single specimen of this new species was obtained by me (1901) on a coral reef, called Inanse, about three miles off Naha (Okinawashima). It was found under a large and living Madreporite mass. The body in the fresh state was about 4.2 *cm.* long and 13 *mm.* thick, while the proboscis was about 23 *mm.* long. The latter appeared to be tubular but laterally expanded at the apex so as to present a bilobed appearance. The body proper was of a bluish violet color, spotted with small, uniformly and closely set papillæ of a dirty green color. The proboscis was yellowish gray, edged with brown on the lateral margins. The two very small ventral hooks are bright yellow.

The longitudinal muscle is continuous. There were three pairs of segmental organs (*so*, Fig. 100) filled with eggs, the most anterior pair lying in front of the ventral hooks (*hk*). The organs appear like elongate sacs and are provided with well developed spiral lobes. The anal glands (*ag*), of a brown color, are remarkably long and reach up to the level of the second pair of segmental organs. Very close to the anterior end they are joined to the body-wall by a slender muscular string. Small funnels with short stalks are sparsely distributed over the surface of the glands. The posterior terminal parts of the rectum are fixed to the body-wall by two muscles, one on each side. No rectal gland is present.

Genus **BONELLIA.****BONELLIA MINOR, MARION.**

(Figs. 23, 101 & 102).

RIETSCH (26), 1886.

SHIPLEY (34), 1899, *p.* 340.

About forty specimens of the above species were collected by me, in April, 1901, in the Riukiu Islands. The body reaches about 2 *cm.* in length and 7 *mm.* in maximum width; the proboscis is 2-2.5 times as long as the body and much narrower (Fig. 23). The color is deep green on the body and a lighter green on the proboscis; the anterior ventral portion of the body shows through the body-wall a reddish color caused by the sexual cells in the oviduct. Thus, in the color of the female the species approaches closer to *Bonellia pumicea* SLUITER (36) than to the Mediterranean specimens of *B. minor*; but the anatomy of the female as well as the general structure of the parasitic male, essentially agrees with the description and figures of the latter species given by RIETSCH except in the one point that the anal glands in the female Japanese specimens bear short branches, from each of which arise about 5-7 funnels which are relatively longer than in the Mediterranean specimens (see Fig. 101).

Fig. 102, drawn from a stained preparation, represents a male which was found in the pharynx of a female. The males

generally measure 1 *mm.* in length and 0.15 *mm.* in maximum breadth, tapering towards the posterior end. As was pointed out by RIETSCU, the skin-surface is thickly ciliated except on the dorsal side where the cuticula is comparatively thicker than in other regions. Two long and strongly curved hooks (*hk*) are present in an anterior position; behind them is seen a large spermatie reservoir (*sv*) provided with a small funnel. The duct of the reservoir begins just behind the hooks and proceeds anteriorly as a narrow tube to open at the apex of the body. This canal (*vd*) is surrounded by a nerve-ring lying just in front of the roots of the ventral hooks.

Habitat: The species is common and readily discoverable in shallow waters in the vicinity of Naha (on Okinawashima, one of the Riukiu Islands). In May, 1900, a few specimens were also collected by MR. MIYAJIMA at Kataura in the Province of Satsuma. The worms live in holes which they bore in dead corals.

BONELLIA MIYAJIMAI, N. SP.

A full description of this species together with figures, will be given in another paper which will appear in this Journal. Here will be given only the more important characters which serve to distinguish the species.

The body measures about 2 *cm.* in length and 1 *cm.* in maximum breadth, the proboscis being six times as long as the body. The color is grayish brown. The ventral hooks, instead of being present in a single pair, number 29 in all; they are arranged on the ventral surface in no definite order. The internal

opening of the unpaired oviduct is found almost at the free end of its thin-walled portion. The main canal of the anal glands divides twice before ending in funnels.

The male worm is of an unusually large size, measuring nearly 28.5 *mm.* in length and 2 *mm.* in breadth. It bears no ventral hook. The alimentary canal is found broken up into innumerable separate pieces which float free in the body-cavity. The vas deferens is internally provided with four large funnels.

Habitat: A single female of the species was discovered on breaking a dead coral, on a coral beach near Tomari, a village two miles from Naha (Okinawashima).

BONELLIA MISAKIENSIS, N. SP.

(Figs. 24, 103–105).

In July, 1896, MR. TOKUNAGA obtained the unique type specimen of this new species on the southern shore of Jōgashima, Misaki. It was found under a large stone near the beach. At the time some sketches and notes were made of the worm by the collector. MR. NISHIKAWA also made a colored sketch of the worm, which is reproduced in Fig. 24. To both gentlemen I am indebted for the material which they placed at my disposal.

According to MR. NISHIKAWA's observation on the living worm, the body proper measured 40 *mm.* in length when contracted and 60 *mm.* when fully extended; the proboscis and its arms measured respectively 50–90 *mm.* and 25–30 *mm.* in length. The proboscis as well as its arms were found to be deeply

furrowed along the midventral line. The form of the body proper was very changeable, but assumed an elongate sac-like shape when preserved. The ground color was a light grayish brown; the body proper and the greater part of the proboscis were densely marked with bluish black spots, while the lateral arms of the proboscis were of a dirty yellow color. As shown in Fig. 24, a number of slender spine-like bodies projected from the entire external surface of the worm.

In the preserved state I have been unable to find the spine-like bodies just mentioned. They had probably fallen off during the killing process; and judging from a figure of the same, drawn by MR. TOKUNAGA, it seems highly probable that they were nothing but parasitic organisms.

Peculiar to this species is the fact that no ventral hook is present and, consequently, no muscular sheath of the same.

Fig. 103 represents the anatomy of the specimen. The oviduct (*od*) is a sac lying on the left side of the nerve-cord, and is nearly as long as the body proper and is fully distended by the ripe eggs contained in it. Anteriorly it is greatly narrowed and its wall highly muscular, while the remaining parts are, on the contrary, much swollen and very thin-walled. The internal opening or funnel, unlike those in all other previously known *Bonellia* species, is not situated near the anterior end of the organ, but is found in the posterior terminal portion. The anal glands (*ag*) are comparatively short and are branched at least three times before ending (Fig. 104). Ten to twenty-five funnels are attached to each of the tertial branches—of course some others being attached directly to the secondary branches. Most of the branches have a fine fixing muscle joining them to the body-wall.

In the alimentary canal and the vascular system, there is no point requiring special mention.

A male worm was discovered in the anterior muscular portion of the oviduct. It is shown in Fig. 105 under low magnification ($\times 56$). Length about 3.3 *mm* ; maximum breadth 0.20 *mm*. The body narrows towards both ends. The entire surface is thickly ciliated. No ventral hook is present. There is an unpaired vas deferens (*vd*), about one-third as long the body-length. It is thickest (0.07 *mm*. across) in the posterior two-thirds of its length, ending with a relatively small funnel (*fn*). The anterior one-third is slender, running forwards through the body-cavity finally to open to the exterior. The external opening is situated not at the very tip of the body, but at a point a short distance behind it on the ventral side (x, Fig. 105). The alimentary canal is found in a state of degeneration similar to that observed in the male of *Bonellia miyajimai*. It does not form a continuous tube, but is broken up into about ten small pieces of different lengths and sizes (*pa*, Fig. 105). These pieces are scattered in the body-cavity, being apparently in no definite relation to one another. The blood corpuscles and sperm-masses are found in abundance, both floating free in the body-cavity.

As to further details of the histology of the male, I have been unable to obtain definite results, owing to the imperfect preservation of the specimen.



**Key to the Genera and Species of Gephyrea treated
of in this Paper.**

Sipunculoidea.

- I.** The longitudinal muscle of the body-wall is divided into 15-31 separate bundles. Two or four retractor muscles present.
- A.**—Body covered with well developed papillae. Hooks usually present on the introvert. Filamentous tentacles arranged in a single semicircle above the mouth. Retractor muscles commonly in two pairs (except in two species, *Phymosoma ono-michianum* and *Phymosoma nahaense*, both which are characterised by having only two muscles). No rectal gland, no ventral vessel. Two distinct eye-spots on the ganglion.....
.....*Genus* PHYMOSOMA. P. 78.
- B.**—Body devoid of papillae. Tentacles filamentous or flap-like, in the latter case they spring from the tentacular membrane. Hooks usually absent. Rectum with one or more caeca. Usually a ventral vessel in addition to the dorsal vessel. No eye-spot*Genus* SIPUNCULUS. P. 79.
- II.** The longitudinal muscle of the body-wall is perfectly continuous.
- A.**—Two segmental organs and a spindle muscle present.
- a.**—Numerous tentacles. Spindle muscle is sometimes fixed posteriorly to the body-wall. Usually two pairs of retractor muscles.
.....*Genus* PHASCOLOSOMA. P. 79.
- b.**—Tentacles spring from four main stems. Hooks, if present, large, but few and scattered. Spindle muscle posteriorly free from the body-wall. Only one pair (ventral) of retractor muscles.
.....*Genus* DENDROSTOMA. P. 80.
- B.**—Only one segmental organ; spindle muscle wanting.
- c.**—Numerous tentacles arranged in a circle round the mouth. Two retractor muscles. The worms belonging to this genus inhabit Molluscan shells.
..... *Genus* PHASCOLION. P. 80.

III. At both ends of the body proper, a horny or calcareous shield. Hooks present. Longitudinal muscle continuous. Only two retractor muscles (fused together generally from their origin).

a.—A horny (rarely more or less calcareous) shield at both ends of the body proper. The introvert is excentric, arising from the ventral side of the anterior or anal shield. Tentacles few and arranged in a single semicircle....*Genus* ASPIDOSIPHON. *P.* 81.

b.—A spiral series of calcareous papillæ forms the anal shield; the posterior, or caudal, shield is wanting. The introvert is extruded from the centre of the anal shield.*Genus* CLÆOSIPHON. *P.* 81.

PHYMOSOMA.

I. 4 retractor muscles.

A.—Dorsal vessel devoid of contractile villi. No collar-like skin-fold behind tentacles.

a.—A single bifurcated fixing muscle. Tentacles about 12. The longitudinal muscle divided into 20–21 bundles. Crescent-shaped markings on the dorsal side of introvert.*P. scolops.* *P.* 20.

b.—Fixing muscle single and simple.

1.—Tentacles about 28. The longitudinal muscle separated into about 30 bundles. Papillæ prominent. Segmental organs long and accompanied by a mesentery along their entire length.*P. japonicum.* *P.* 22.

2.—Tentacles 35–40. Longitudinal muscles, 30–35. Papillæ remarkably prominent. Segmental organs short and accompanied by a mesentery along the anterior half of their length.
.....*P. pacificum.* *P.* 25.

B.—Dorsal vessel with contractile villi. A collar-like fold behind tentacles.

Tentacles very numerous (50–80). Papillæ small and low. Longitudinal muscle varying in the number of bundles....*P. antillarum.* *P.* 24.

II. 2 retractor muscles.

- a.*—Hooks provided with one apical tooth. Dorsal vessel devoid of contractile villi.....*T. nahaense*. P. 29.
b.—Hooks wanting. Papillæ prominent. Contractile villi numerous and ramified.....
*T. onomichiannum*. P. 26.

SIPUNCULUS.

- A.**—Tentacles flap-like. The chitin over the body proper folded into rectangular areas. Introvert with very tall, posteriorly directed papillæ. Longitudinal muscle separated into 31 bundles.....*S. nudus*. P. 31.
B.—Tentacles filamentous. Body-surface shows no rectangular areas. Introvert and body proper covered with skin-bodies.
a.—Longitudinal muscles 18–21. Crescent-shaped dissepiments on the inner side of the body-wall. With a bifurcated fixing muscle....*S. eumanensis*. P. 32.
b.—Longitudinal muscles 15. Devoid of crescent-shaped dissepiments. Fixing muscles 2.....
*S. amamiensis*. P. 38.

PHASCOLOSOMA.

I. 2 retractor muscles.

No hook. Introvert long. Body as a whole coiled into a spiral.....*P. nigrum*. P. 3.

II. 4 retractor muscles.**A.**—With hooks and 1–2 fixing muscles.

- a.*—Hooks provided with 4–5 small accessory teeth and arranged in ring-rows. A single fixing muscle. Segmental organs consist of two elongate lobes directed oppositely.*P. misakianum*. P. 7.
b.—A somewhat larger form. Hooks dispersed, almost straight, and devoid of accessory teeth. 2 fixing muscles. Segmental organs of an ordinary shape....
*P. ovstoni*. P. 12.

B.—No hooks; with 3 fixing muscles.

a.—Eye-spots present. No respiratory apparatus on the body proper. Littoral form. ... *P. japonicum*. P. 5.

b.—Eye-spots wanting. Respiratory apparatus present over the surface of the body proper. Deep-sea form. *P. okinoseanum*. P. 9.

DENDROSTOMA.

I. Hooks generally wanting.

A dark-blue marking at the middle of the introvert. 3 fixing muscles. Contractile villi numerous, long and branched. Spindle muscle posteriorly free from the body-wall.
..... *D. signifer*. P. 56.

II. Hooks present.

A.—Tentacles short but very numerous. Hooks very large (0.20 mm. high). Contractile villi few, but remarkably long. 3 or 4 fixing muscles. *D. blautum*. P. 53.

B.—Tentacles relatively long, about 8–12 of which branch off from one of the 4 main stems. Hooks small (0.04–0.06 mm. high) and about 50 in number. Contractile villi short and numerous. Fixing muscles indefinite in number (0–3).
..... *D. minor*. P. 57.

PHIASCOLION.

I. Body straight. Papillary bodies are in general small and the middle part of the body proper seems almost smooth. A single retractor muscle with two short roots. 4 fixing muscles.

..... *P. rectus*. P. 15.

II. Body coiled into a spiral. The middle part of the body proper covered with especially large papillæ. 2 retractor muscles, one of which is much more slender than the other. No fixing muscle. *P. artificiosus*. P. 18.

ASPIDOSIPHON.

- I.** Skin-papillæ distinct. A single fixing muscle and a rectal gland present.

A.—Both anal and caudal shields present.

a.—The two shields radially grooved.

1.—Longitudinal muscle separated into very irregular bundles. Retractor muscles arise from the inside of the caudal shield....*A. truncatus*. P. 38.

2.—Longitudinal muscle separated into more or less regular bundles. Retractor muscles arise far anterior to the caudal shield....*A. steenstrupii*. P. 40.

b.—The peripheral border of the anal shield only is lightly grooved.

Longitudinal muscle continuous. Retractor muscles arise just in front of the caudal shield.

.....*A. misakiensis*. P. 41.

B.—Caudal shield indistinct.

The anal shield is of the shape of a tall, obliquely directed cone; it is very thick and calcareous, and its surface roughened by the presence of distinct radial ridges and grooves....

.....*A. uniscutatus*. P. 43.

- II.** No papillæ over the greater part of the body proper. No fixing muscle or rectal gland.

a.—The two shields show a prominent circular ridge, on both sides of which are present longitudinal ridges and grooves. Hooks have a bluntly pointed apex. No fixing muscle or rectal gland.

.....*A. angulatus*. P. 45.

b.—The two shields show a granular appearance. Hooks two-toothed at apex. The greater part of the introvert-surface covered with scattered spines....

.....*A. spinalis*. P. 47.

CLOESIPHON.

- Only one species is known in this country.....*C. japonicum*. P. 49.

Echiuroidea.

- I.** Proboscis not bifurcated at apex, but truncated transversely. Sexes of similar appearance.
- A.**—Anal hooks arranged in 1 or 2 circles. 2 pairs of segmental organs. *Genus* ECHIURUS. P. 82.
- B.**—No anal hook. 1-3 pairs or more of segmental organs.....
..... *Genus* THALASSEMA. P. 82.
- II.** Proboscis bifurcated at apex. Sexual dimorphism remarkably pronounced.
- No anal hook. Unique segmental organs.....
..... *Genus* BONELLIA. P. 83.
-

ECHIURUS.

Anal hooks arranged in a single circle. No definite blood vessel.
..... *E. uncinatus*. P. 59.

THALASSEMA.

- I.** Longitudinal muscle continuous.
- A.**—Segmental organs in only one pair; the internal openings of the organ lack spiral lobes.
- a.**—Body of a small size. Ventral hooks provided internally with a well developed interbasal muscle....
..... *T. owstoni*. P. 62.
- b.**—Skin-papille prominent over the whole surface. No interbasal muscle. *T. fuscum*. P. 69.
- B.**—Segmental organs in 3 pairs; provided with spiral lobes.
- a.**—The anteriormost pair of segmental organs lie in front of the ventral hooks. *T. inansense*. P. 71.
- b.**—All segmental organs lie behind the ventral hooks.
..... *T. mucosum*. P. 68.

C.—Segmental organs indefinite in number, always more than 3 pairs.

a.—Segmental organs very numerous, small and not provided with spiral lobes. Proboscis remarkably long. *T. tenioides*. P. 63.

b.—Segmental organs grouped commonly into 7 pairs, each group consisting of 0-3 large organs; they are provided with spiral lobes. Proboscis nearly as long as body. *T. elegans*. P. 65.

c.—Segmental organs, in the female, in 3 pairs, while in the male they are found in 6 or 8 groups arranged pairwise, each group consisting of 1-4. The shape of the organs is like that of *P. elegans*. *T. gogoshimense*. P. 66.

II. Longitudinal muscle divided into 18 broad bundles.

Segmental organs in 3 pairs, the anteriormost pair being situated in front of the ventral hooks; they are provided with short spiral lobes. A large rectal gland present. *T. kokotoniense*(?) P. 60.

BONELLIA.

I. Very numerous ventral hooks in the female and no hook in the male.

The female worm bears a grayish brown color; a large form. Parasitic male of a remarkably large size.
..... *B. miyajimai*. P. 73.

II. No ventral hook in either sex.

The female of a grayish brown color, spotted with a deep bluish black pigment. *B. misakiensis*. P. 74.

III. Two ventral hooks present in both sexes.

Color bright green on body and pale green on proboscis. A small form, living in dead corals.... *B. minor*. P. 72.

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to me in working out the present study.**

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List of Abbreviations used in the plates.

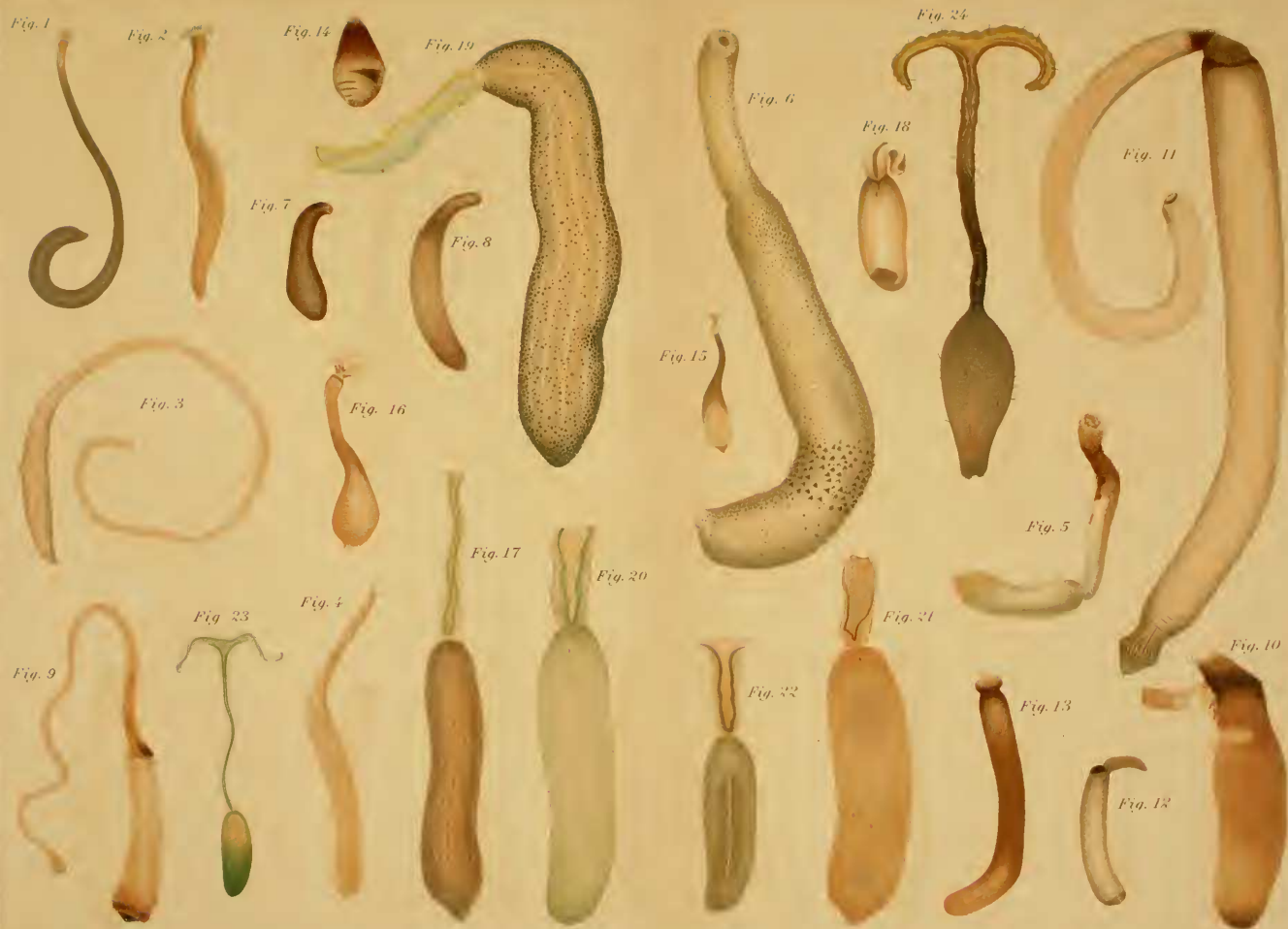
<i>a.</i> , Anus.	<i>nc.</i> , Nerve-cord.
<i>ag.</i> , Anal gland.	<i>ni.</i> , Neuro-intestinal vessel.
<i>b.</i> , Transverse bar of hook.	<i>ol.</i> , Oviduct.
<i>cv.</i> , Contractile villi.	<i>oe.</i> , Œsophagus.
<i>dm.</i> , Dorsal muscle.	<i>pa.</i> , Pieces of digestive canal.
<i>dv.</i> , Dorsal vessel.	<i>ph.</i> , Pharynx.
<i>em.</i> , Erector (or radiating) muscle of ventral hook.	<i>rg.</i> , Rectal gland.
<i>fm.</i> , Fixing muscle.	<i>rt.</i> , Reticular tissue.
<i>fn.</i> , Ciliated funnel.	<i>w.</i> , Warts or 'Runzeln.'
<i>g.</i> , Ganglion.	<i>sm.</i> , Spindle muscle.
<i>hk.</i> , Hook.	<i>so.</i> , Segmental organ.
<i>ht.</i> , Heart.	<i>sr.</i> , Spermatoc reservoir.
<i>ic.</i> , Intestinal convolution.	<i>sv.</i> , Sexual organ.
<i>im.</i> , Interbasal muscle of ventral hook.	<i>vl.</i> , Vas deferens.
<i>m.</i> , Mesentery.	<i>vm.</i> , Ventral muscle.
<i>mf.</i> , Muscle-fibres.	<i>wm.</i> , Wing-like muscle.

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THE GEPHYREA OF JAPAN.

PLATE I.

- Fig. 1.—*Phascolosoma nigrum*, n. sp. Natural size.
Fig. 2.—*Phascolosoma japonicum*, n. sp. Natural size.
Fig. 3.—*Phascolosoma misakianum*, n. sp. About 7 times enlarged.
Fig. 4.—*Phascolosoma okinoseanum*, n. sp. Natural size.
Fig. 5.—*Phascolosoma owstoni*, n. sp. Natural size.
Fig. 6.—*Phascolion artificiosus*, n. sp. About 10 ×.
Fig. 7.—*Phymosoma onomichianum*, n. sp. Natural size.
Fig. 8.—*Phymosoma nahaense*, n. sp. Natural size.
Fig. 9.—*Aspidosiphon misakiensis* n. sp. 2 ×.
Fig. 10.—*Aspidosiphon uniscutatus*, n. sp. Greatly magnified.
Fig. 11.—*Aspidosiphon angulatus*, n. sp. 10 ×.
Fig. 12.—*Aspidosiphon spinalis*, n. sp. 3 ×.
Fig. 13.—*Oliosiphon japonicum*, n. sp. Natural size.
Fig. 14.—*Dendrostoma blandum*, Sel. and De Man. Natural size.
Fig. 15.—*Dendrostoma signifer*, Sel. and De Man. Natural size.
Fig. 16.—*Dendrostoma minor*, n. sp. 5 ×.
Fig. 17.—*Thalassema kokotoniense*, Fischer (?). Natural size.
Fig. 18.—*Thalassema owstoni*, n. sp. 2 ×.
Fig. 19.—*Thalassema gogoshimense*, n. sp. Natural size.
Fig. 20.—*Thalassema mucosum*, n. sp. Natural size.
Fig. 21.—*Thalassema fuscum*, n. sp. Natural size.
Fig. 22.—*Thalassema inansense*, n. sp. Natural size.
Fig. 23.—*Bonellia minor*, Marion. Natural size.
Fig. 24.—*Bonellia misakiensis*, n. sp. Natural size.



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THE GEPHYREA OF JAPAN.

PLATE II.

Phascolosoma nigrum.

Fig. 25.—A papilla from the posterior body region. 180 $\times$.

Eig. 26.—A papilla from the introvert. 180 $\times$.

Fig. 27.—A specimen dissected.

Phascolosoma japonicum.

Fig. 28.—Skin with chitinous bodies from the middle body region. 265 $\times$.

Fig. 29.—A specimen dissected.

Phascolosoma misakianum.

Fig. 30.—A papilla from the posterior body end; *a* in longitudinal optical section and *b* in surface view. 180 $\times$.

Fig. 31.—A perforated papilla from the introvert. 410 $\times$.

Fig. 32.—A hook from the introvert; side view. 410 $\times$.

Fig. 33.—A specimen dissected.

Phascolosoma okinoseanum.

- Fig. 34.—A papilla from the posterior body end. Zeiss Oc. 2 and Obj. Imm. $\frac{1}{12}$.
Fig. 35.—Papillæ from the introvert basis. 180 $\times$.
Fig. 36.—A sac-like respiratory organ on the skin. 65 $\times$.
Fig. 37.—Basal part of the same. Zeiss Oc. 2 and Obj. Imm. $\frac{1}{12}$.
Fig. 38.—A specimen dissected.

Phascolosoma owstoni.

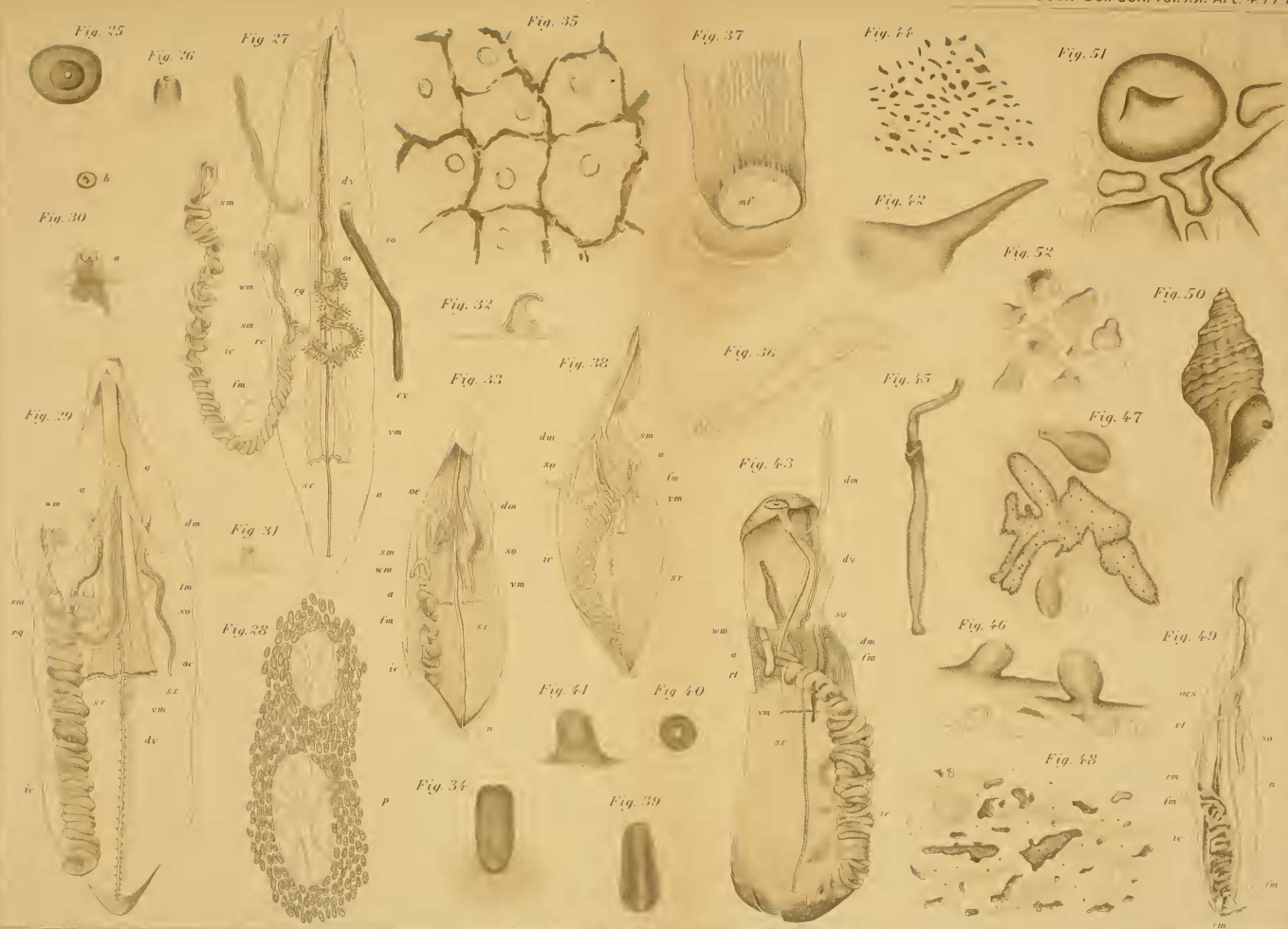
- Fig. 39.—A papilla from the posterior body region. 180 $\times$.
Fig. 40.—A papilla from the introvert basis. 180 $\times$.
Fig. 41.—A papilla from the introvert. 180 $\times$.
Fig. 42.—A hook from the introvert. 180 $\times$.
Fig. 43.—A specimen dissected.
Fig. 44.—Magnified surface-view of the peculiar reticular structure on the inside of the body-wall. Zeiss Oc. 3 and Obj. a_2 .

Phascolion rectus.

- Fig. 45.—The whole worm-body. 2 $\times$.
Fig. 46.—Papillæ from the middle parts of the introvert. 330 $\times$.
Fig. 47.—Papillæ and chitinous thickenings of the skin at the introvert-basis. 200 $\times$.
Fig. 48.—Papillæ from the posterior end of body. 330 $\times$.
Fig. 49.—Specimen dissected.

Phascolion artificiosus.

- Fig. 50.—Gastropod shell containing the worm. 2 $\times$.
Fig. 51.—Large papillæ seen from above. 200 $\times$.
Fig. 52.—Small papillæ from the middle region of the introvert. 330 $\times$.



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THE GEPHYREA OF JAPAN.

PLATE III.

Phascolion artificiosus (continued).

- Fig. 53.—Papillæ from the posterior end of body. 200 $\times$.
Fig. 54.—Finger-shaped papillæ from the basis of the introvert. 200 $\times$.
Fig. 55.—A specimen dissected.

Phymosoma onomichianum.

- Fig. 56.—A papilla from the middle body region. 180 $\times$.
Fig. 57.—A papilla from the introvert-basis; *a* side view; *b* surface view. 180 $\times$.
Fig. 58.—Specimen dissected.

Phymosoma nahaense.

- Fig. 59.—A papilla from the middle body region. 265 $\times$.
Fig. 60.—A hook from the introvert; side view. 265 $\times$.
Fig. 61.—A perforated papilla of the introvert; side view. 265 $\times$.
Fig. 62.—A specimen dissected.

Sipunculus cumanensis.

- Fig. 63.—Portion of a transverse section through the body-wall, showing the structure of the 'ovale Gebilde.'

Sipunculus amamiensis.

- Fig. 64.—A papilla from the middle body region; surface view. 294 $\times$.
Fig. 65.—A specimen dissected.

Aspidosiphon truncatus.

- Fig. 66.—A hook from the introvert; side view. 410 $\times$.
Fig. 67.—A perforated papilla from the introvert; side view. 410 $\times$.

Aspidosiphon misakiensis.

- Fig. 68.—Anterior end of body, showing the anal shield. 20 $\times$.
Fig. 69.—A hook; side view. 600 $\times$.
Fig. 70.—One of the spines found scattered on the introvert; side view. 600 $\times$.
Fig. 71.—A perforated papilla lying between hook-rows. 294 $\times$.
Fig. 72.—A specimen dissected.

Aspidosiphon uniscutatus.

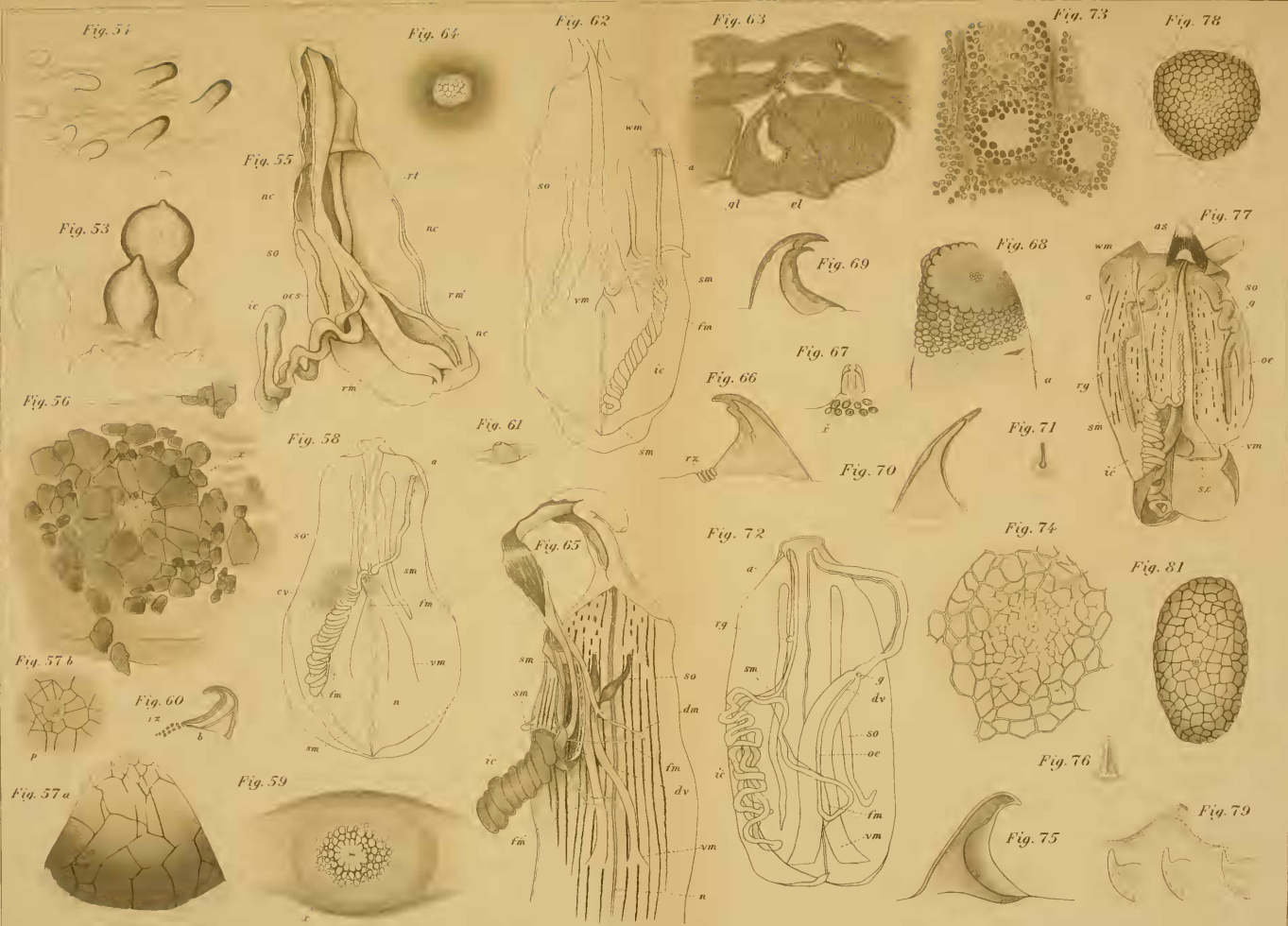
- Fig. 73.—Magnified view of the basal parts of a longitudinal ridge of the anal shield. 95 $\times$.
Fig. 74.—A papilla from the middle body region. 410 $\times$.
Fig. 75.—A hook from the hook-rows; side view. 680 $\times$.
Fig. 76.—A perforated papilla lying between the hook-rows. 680 $\times$.
Fig. 77.—A specimen dissected.

Aspidosiphon angulatus.

- Fig. 78.—A papilla from the posterior body-region; surface view. 265 $\times$.
Fig. 79.—Hooks and perforated papillæ from the introvert. 410 $\times$.
Fig. 80.—A specimen dissected. (This figure has been inserted in Pl. III).

Aspidosiphon spinulatus.

- Fig. 81.—A papilla lying near the caudal shield; surface view. 265 $\times$.



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PLATE IV.

(For explanation of Fig. 80, see under Pl. III.)

Aspidosiphon spinalis (continued).

- Fig. 82.—One of the spines scattered on the introvert. 294 $\times$.
Fig. 83.—A hook from the ring-rows on the introvert; side view. 294 $\times$.
Fig. 84.—A perforated papilla from the introvert; side view. 294 $\times$.
Fig. 85.—Specimen dissected.

Clavosiphon japonicum.

- Fig. 86.—Magnified view of the calcareous shield. Zeiss Oc. 2 and Obj. aa.
Fig. 87.—A papilla from the middle body region; surface view. 410 $\times$.
Fig. 88.—A papilla from the introvert-basis; side view. 180 $\times$.
Fig. 89.—A hook and a perforated papilla from the introvert. 410 $\times$.

Dendrostoma blandum.

- Fig. 90.—Side view of the main stems of tentacles. 20 ×.
Fig. 91.—Magnified view of a portion of the digestive canal, showing the rectal gland (*rg*), the fixing muscles (*fm*), etc. 5 ×.

Dendrostoma minor.

- Fig. 92.—A papilla from the posterior body end; surface view. 294 ×.
Fig. 93.—Side view of a papilla from the hooked region of the introvert. 265 ×.
Fig. 94.—One of the scattered hooks of the introvert. 410 ×.
Fig. 95.—A specimen dissected.

Thalassema orstoni.

- Fig. 96.—Specimen dissected; the greater part of the digestive canal is cut off. 3 ×.
Fig. 97.—Magnified figure of a segmental organ.

Thalassema mucosum.

- Fig. 98.—Magnified view of a dissected specimen, showing only the anterior body end.

Thalassema fuscum.

- Fig. 99.—Magnified view of a dissected specimen, showing only the anterior body end.

Thalassema inansense.

- Fig. 100.—Specimen dissected; the greater part of the digestive canal is cut off.

Bonellia minor.

- Fig. 101.—Distal portion of an anal gland of the female. 20 ×.
Fig. 102.—Male worm, drawn from a stained toto preparation. 131 ×.

Bonellia misakiensis.

- Fig. 103.—Specimen dissected, all internal organs *in situ*. 2 ×.
Fig. 104.—One of the secondary branches of the anal gland. Highly magnified.
Fig. 105.—Male worm, drawn from a stained toto preparation. 56 ×.

